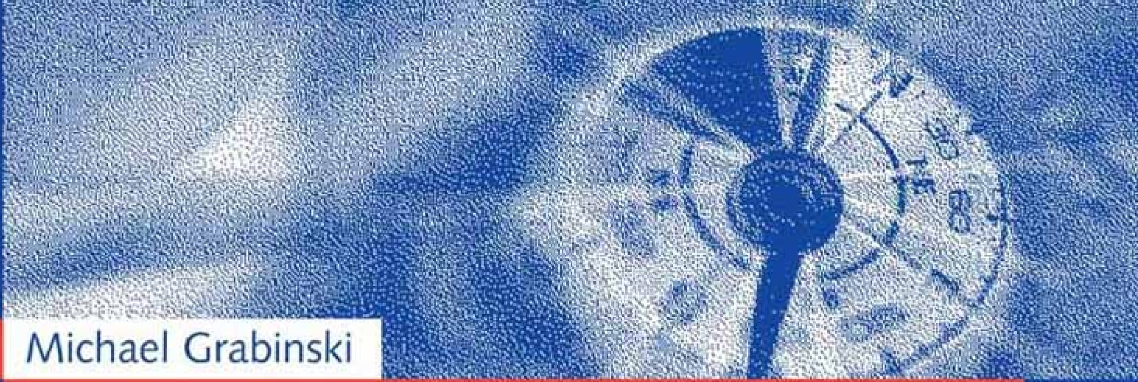

Michael Grabinski

Management Methods and Tools

Practical Know-how for Students, Managers, and Consultants

Lehrbuch

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Preface

The idea to write this book dates back many years. When I was a young management consultant, from time to time my colleagues and I would be assigned to prepare a “toolbox.” Just as a handyman needs proper tools, so do managers and consultants. Corporate managers often assume that good consultancies have excellent toolboxes enabling them to achieve awesome success in operational and strategic projects. Arguably, top management consultancies are successful in managing their projects. To my knowledge, however, such magic toolboxes do not exist. My colleagues and I never managed to complete any assignment to create a toolbox, because it was always more important for us to be working in the field in order to generate revenue. On the other hand, those few fragments of toolboxes that we did prepare were treated like secret treasures. Now, naturally, no big consultancy is willing to publish its proprietary tools. Thus, while I am convinced that a toolbox is necessary for both managers and consultants alike, I also believe that it only can be developed outside of a consultancy (albeit by someone with knowledge as to what goes on inside of consultancies).

There already exist many books dealing with management and strategy, of course, but none of them fits the aforementioned purpose. As a young consultant, I had many colleagues with MBAs or doctorates from such famous universities as St. Gallen, Harvard, INSEAD and others. They would consult their textbooks when faced with such a problem as, for example, how to create a new organization. Other than musings on academic or even scientific issues, they found nothing in such books that was useful and relevant to the questions at hand. Today, I also am an academic. My goal is to teach my students only *relevant* things that a top manager needs to know. I would love to have a proper textbook for this purpose, but I have never found one that is suitable. Therefore, I write my own detailed handouts for lecturing. It is the summarizing of these "scripts" (as we call them in Europe) and bringing them into a form that is acceptable for students and managers alike that provided the basic content of the present book.

This book contains many, and perhaps even most, of the necessary tools for managers. But it does not contain everything that is needed. I held to two guidelines for limiting the scope of the book. Firstly, I do not comment on areas were proper books already do exist (e.g., marketing, accounting, logistics). Secondly, I am dealing only with areas in which I have thorough personal experience. The first guideline has a further implication. I thought for a long time about what literature I should cite. If I want to reference literature dealing with the topics of this book, then I would be forced to comment on those books that are not suitable for further reference. In doing so, I would create no value for the reader. Furthermore, I would have to quibble about the shortcomings of my colleagues' works rather than to tell something useful for the reader. I will leave that manner of work to the politicians, many of whom cannot tell what is good for the country but are very good at criticizing the suggestions from other parties. All in all, therefore, I am convinced that this book will be much better if no literature is cited. The book will thus be disqualified as an academic piece of work or even as a scientific one. I am not at all ashamed of that, and, in fact, it is perhaps even something to be proud of.

During my time in business, I led about 25 major projects. They were sometimes easy, and sometimes they demanded that I develop a complicated analysis. Especially in the beginning, I tried to find answers – or at least hints – in the literature. With regard to those projects I worked on, I can definitely say that I never found anything useful in any kind of literature. The present book is designed in a way that I would have loved to have had it 15 years ago.

Finally, but very importantly, I want to say thank you to all the people who helped me to gain the necessary experience to write this book.

Former colleagues in management and consulting enlightened me during many discussions. The same is true for a long list of clients. I did the best that I could to help them to excel in their businesses. By allowing me to work with them in solving their problems, they helped me to gain the necessary practical experience indispensable for writing this book. Without that, this book would be of purely another theoretical exercise. A very special thank you goes to Gale A. Kirking for proofreading the entire manuscript. Many valuable hints improved the quality of this book.

Frankfurt am Main, December 2006

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Figures

All figures above are available online. Please contact the author at mg@alumni.caltech.edu.

1 Introduction

This book is designed for everybody who wants to learn how to manage or to improve existing management skills. A manager is a person who decides what to do and, in part, how to do it. The underlying aim is normally to be as efficient as possible. In the language of most businesses, that means to be as profitable as possible. One may ask how efficiency is defined or what profitability exactly means and how it is measured. Applying a suitable definition and measurement procedure is one skill a manager needs (although this book does not cover it), but there are many more skills required. Examples are how to determine whether a business is developing in the right direction or who should do what. This book aims to teach these kinds of skills. They are taught here in the forms of methods and tools.

Management, in the sense addressed in this book, has been around ever since big companies came into existence. About 100 years ago, Frederick W. Taylor presented his principles of scientific management. His were among the first major theoretical thoughts about management. Many more thinkers have followed him right up to the present. Today, most managers have formal educations in business and management. The MBA is probably the best-known such degree. Most MBA degrees are offered by business *schools*. I intentionally use the word "school" here rather than "university" because, while I personally associate universities with teaching science, I do not regard management as science. Please note that this does not mean that a manager does not need to be smart. On the contrary, good management requires high intelligence in the same way as does science. But that does not imply that management is a science. The task of a scientist might be, for example, to understand how the universe formed. The corresponding task of a manager is to make the production of a universe most efficient. In this example, the task of the manager is far more difficult than is that of the scientist. But it is absolutely not science. Of course, humankind is not yet producing universes. The things humankind does produce are pretty simple by comparison, and the science underlying that production was typically well understood long ago. Otherwise, production would not be possible. Consider a vacuum cleaner as an example. The science behind it is trivial, and its basic engineering is only a bit more complicated. But to reduce the cost to produce a vacuum cleaner, now that is a challenge. Perhaps this is why academics in management especially feel compelled to emphasize over and over their scientific approach. Besides feeding their own vanity, this results in a business education that is overly theoretical. Although business schools are a step in the right direction, they still are often too academic in their approach. One way to overcome this problem is to learn by doing, and in general that is not a bad method. Experience is so important in management that most people who become CEOs are over the age of 50. By contrast, scientists becoming professors are often under the age of 40. While Nobel Prizes are awarded mostly to people in their retirement years, these are usually for discoveries made between the ages of 25 and 45. Obviously, to be a top performer in management requires more years than to achieve the same in science. In my opinion, there are three reasons for this (the first of which is clear from the remarks above):

- Most relevant education takes place on the job.
- Management is more difficult than science.
- To be a leader as well as a manager requires a certain age.

As I have mentioned, learning by doing is good in any discipline. It entails some waste, however, if the wheel must be invented over and over again. To minimize this loss is one of the goals of this book. My second claim would probably be welcomed by business academics but dismissed by scientists. I have worked extensively in both of these worlds, and I can confirm it without reservation. Management is a far younger discipline than is science, and its basic rules are still undiscovered. The content of this book represents one small step toward identifying those rules.[1] Please note that while management is more difficult than science, this does not imply that managers are smarter than scientists. Another point as to why management is more difficult than science is closely related to the third point above. Management has to do with people, and people are far more complicated than are, for example, elementary particles. Although management is distinct from leading, the two skill sets are often intertwined. (For a thorough definition of management and leadership, please see 7.4.4.) Leading involves people and the relations and emotions between them. To understand such things is rarely possible before the age of 40.

In addition to these general remarks, I will provide two sets of practical hints in this introduction. One is about how to use this book (1.1). The other states what kind of learning one may expect from reading this book or parts of it (1.2).

1.1 How to use this book

This book is a "toolbox." When somebody buys ordinary tools, some manual is normally included. Here I will present a "manual" for this book. The book is designed for anybody who wants to learn something about management. Students of any field (not necessarily business) who plan to work in management should read this book in order to prepare themselves for their future jobs. Managers and consultants at any level, meanwhile, will find guidance for solving most of the problems they face in their daily work.

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[1] Some parts of this book deal heavily with numbers and mathematical formulas. These parts are definitely easier than science. In order to find those areas where management is more difficult than science, one has to look through the parts where there are no formulas.

As is probably true of most authors, I would love if many people would read this book from beginning to end. It is not a handbook or even an encyclopedia of methods and tools. Rather, the chapters are ordered in a way that makes reading most interesting and easy. Up to chapter 5, it is necessary to have at least a reasonably sound knowledge of the respective chapters preceding.

This book contains no exercises. For anybody already working in business, the best exercise is to apply the suggestions from this book to solve daily problems. In any case, it will be useful while reading to reflect on how the ideas presented here can be related to day-to-day problems or situations in one's real world. For most readers, it will be necessary to *work* their way through the book. Therefore, it may be necessary to read particular passages several times. Parts of this book deal with difficult topics[2], and difficult things are by definition not understood on the spot.

Readers looking for ready-made methods or tools will do so in vain. Any method or tool must be understood first before one can use it. Even then, it should be adapted to the specific situation and need. I intentionally designed the book in this way. I have two objections to books with ready-made remedies. First, it is scarcely possible to find a real business situation where the suggested solution actually fits. Second, blindly employing such remedies often leads to situations where they are used beyond the range of their applicability. As we often said as consultants: "A fool with a tool is still a fool." In part, this book may be understood as a helping hand. But just as a helping hand is indispensable for toddlers, eventually one must learn to walk on one's own.

I tried hard to write this book in such a form that no special knowledge would be necessary in order understand it. It was my goal to write a book useful for university freshman, graduate students, and

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[2] I favor Einstein's remark here: "Everything should be made as simple as possible but not simpler.

experienced managers or consultants. By and large, I think I achieved this. In the field of business, though, a knowledge of such basic terms and concepts as revenue, cash flow, or return on investment is helpful. Typically, a business major will learn these things within his or her first term. Some chapters involve some mathematics, but a good high school graduate should be able to master it. The appendices go beyond this level, but understanding the appendices is not essential to comprehending the book. Nevertheless, some background knowledge can be found there. In a very few places, the book deals with mathematics beyond the high school level (7.1 or 7.3). It was unavoidable there. Even that mathematics, though, is not beyond that taught during the first year at university in most fields.

1.2 What to expect

As stated several times already, this book explains the skills necessary to manage a business. The general goal of *every* business is to be profitable. The only variation is whether to be profitable in the short run or long term. (In principle this applies even for charities and nonprofit organizations.) A manager has only two ways to improve profitability. One is to lower costs and the other is to increase revenue. All other concerns such as high quality products, motivated employees, or investing in high technology are useful only if they are helpful in lowering cost or increasing revenue. From this, one might conclude that a manager has to know just two things (you guessed it): How to lower cost and to increase revenue. One could argue, therefore, that this book should have had two chapters only. One should be called "How to lower cost" and the other "How to increase revenue." Books are available that deal with one or both topics. Typically, they are in the form of "100 ideas for…" They might be quite useful, and especially if a manager has to solve a specific problem in the short run. In my opinion, though, they are not suitable for long-term considerations and a thorough understanding.

Therefore, I have taken a different approach here. I am explaining typical things a manager has to do in order to achieve his or her major goal. Please note that none of these should be done for their own sake. The reason for applying the methods and tools presented here is always to increase revenue or to lower cost, at least in the long run.

The arguably most essential task a manager has is to organize. In short, organizing means to decide "who should do what" and "who is reporting to whom." Chapter "5 Organization" of this book deals with this problem. One may consider the organization of an entire company or just the organization of next week's work. The logic behind it is always the same. Please understand that to change an organization never reduces costs directly. The change may lead to increased revenue because one can serve the market better, or cost savings created by other means may require a new organization. To organize is an almost daily job of a manager, and especially if it is defined as broadly as it is here. Therefore, chapter 5 – or more precisely 5.2.2 – is undoubtedly the most important one in this book. Nevertheless, just reading these 12 pages is most likely of very limited help. Almost everything written here prior to 5.2.2 is essential for understanding that section (and many other methods and tools presented here).

Chapter 2 is about business process modeling. In simple terms, it is a standard way to describe what is done in a business. Obviously, one must first write down what is done before one can think of organizing it. Besides its being indispensable for organization, process modeling is mandatory for controlling (4), balanced scorecard approaches (3), reengineering (5.5), activity based costing (6.3) and many more activities. I am aware of no manager who does not need to know about it, and a big chunk of all consultants' revenues comes from modeling processes. Please note that it is by no means limited to IT problems, such as introducing a new ERP system. I deliberately stress here its importance outside the IT world. (For IT applications, some useful literature can be found. Otherwise, there is none other available.)

The third chapter deals with the buzzword "balanced scorecard" (BSC). In simple terms, this is about finding the right quantities to indicate how the business is getting along. There are thousands of publications on this topic. Here, I will focus on the basic ingredients, and I will stress typical problems and mistakes. One of the key findings is that balanced scorecard is the one and only method for determining performance indicators. Therefore, it is clear that the idea of BSC is much older than the publications of Robert S. Kaplan and David Norton on the subject. While they are not the inventors of BSC, Kaplan and Norton are the people who made BSC happen – and that is arguably a much bigger achievement. A second finding that is not so common but is nevertheless important of chapter 3 is that BSC is closely related to organization. To find proper performance measures may require a change of the organization.

In chapter 4 (controlling), I show how to use the performance indicators defined via BSC. As is the case with BSC, there are many books and publications on controlling. I will emphasize the basic steps and the typical but fundamental mistakes that occur. Again, it will become clear that controlling is very closely related to organization. In order to make a proper controlling possible one has to choose a certain organization. (Indeed, chapter 5 will make clear that enabling a proper controlling is *the* construction rule for a new organization.) A second rarely considered finding of chapter 4 is the fact that, for reasons that are fundamental, controlling is not always possible. The consequences of this should be clear. First, attempting to control under such circumstances is a complete waste. Second, management is scarcely possible in such a situation.

Chapter 5 deals with organization, as mentioned above. Some additional, related topics are discussed there. In 5.3 , I will explain how many people should be working in a single organizational unit. A fairly new approach of using a so-called feedback circle is discussed in 5.3.3. The number of people one person leads is commonly referred to as a span of control. In 5.4 , I will show that there is an *optimal* span of control (typically 8 to 10). Values below and above this optimum will lead to higher costs. In 5.5 , I will demonstrate that reengineering is a very proper tool and not just a fashionable buzzword from the 1990s. Process organization is sometimes considered a new organizational form. In 5.6, I will make clear that it is the (one and only reasonable) way to find an optimal organization. "Self-organization" is considered a situation where an organization changes (for the better) without any interference by the management. In addition to discussing its usefulness and difficulties, I will clearly affirm in 5.7 that it has nothing to do with such almost spooky things as violating one of the most fundamental laws of physics (increase of entropy).

In chapter 6 , I will shed light on some quantitative methods and tools that are often used. One quite general conclusion will be that, in calculating, one must always take into account a margin of error (6.1.2). By doing so, one will see that quite a few cost calculations are a complete waste of time because their margin of error is too high. There even are situations where it is quite impossible to decide whether a particular product leads to a profit or loss. So-called semi-quantitative methods are used to evaluate, for example, a strategy by assigning scores to certain features. In 6.2, I will show the typical mistakes that are made, and especially if the total score is built by multiplying the individual scores. 6.4 explains a neat tool to determine the (market-driven) target cost of a product and its components. 6.5 will lead to the frontier of research in management. Here, the chaos theory is applied to show that very small causes can result in enormous effects. Consequently, one can show that, for example, supply chain networks are sometimes fundamentally not manageable. The same can be true for complex projects. Therefore, a fundamental change in management approach is necessary.

In chapter 7 , additional tools and methods to manage an operation are scrutinized. The central task of planning is reviewed in 7.1. By applying a simple model, it is possible to calculate the margin of error of a plan or forecast. Long-term planning can easily lead to a margin of error of, say, 100%. That points to severe consequences for the usefulness of business plans. In the next tool discussed (benchmarking), one compares two businesses. The goal of 7.2 is to point out mistakes that are avoidable. In the third subchapter learning curves are discussed. Everything that is done repeatedly will lead to learning, and normally to higher efficiency. The exact form of such learning curves is derived in 7.3. The result is indispensable for any kind of controlling where learning is involved. This book ends with some hints on soft skills (7.4). This important topic can easily fill an entire book. The aim here is to encourage the reader to think about it thoroughly.

2 Business process modeling

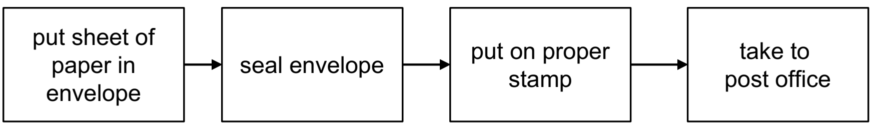
At least since business process reengineering was introduced by Michael Hammer in the early 1990s, business process modeling has become a "standard" tool. Although business process modeling is important, there is hardly any real standard. There is no agreement as to what business process modeling exactly is, as to what it is good for, or even whether it is useful at all. The point of this chapter is to provide some clarification. Business process modeling is very useful – and even far beyond the information technology world. It will have its application in almost all of the following chapters, and I will especially stress its usefulness outside of IT.

What is a process? In the business world, at least, a process is an orderly progression of things that need to be done to achieve some purpose. Consider, for example, the process for mailing a letter. The necessary steps are:

- put the sheet of paper in an envelope
- seal the envelope
- put a proper stamp on the envelope
- take the envelope to a post office

The four steps above comprise a model of the mailing process. (It is merely a model, rather than the process itself, as the process can be

Fig. 2-1: *Mailing process in four steps*

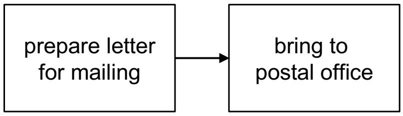


performed but it cannot be written in a book.) In process modeling, one must describe the way a process proceeds. This can be done in the way shown above, but there are many more ways. One can easily write a full-page story about it. Another way is take a graphical approach, as shown in Fig. 2-1. The main question is: “What is the best way?” Well, in fact, there is no single, universal answer. The answer depends on the intended *purpose*. The description or process modeling in Fig. 2-1 is useless, for example, if one wants to describe a funny scene from Mr. Bean. For modeling business processes, the method represented by Fig. 2-1, or something close to it, is used quite often. That does not mean that some other way must be wrong for business purposes, although the approach of Fig. 2-1 has many advantages, such as that it:

- is simple.
- gets to the point.
- is easy to view.
- clearly separates the steps.
- is easy to translate into another language.
- …

While Fig. 2-1 sets down a certain direction for modeling a business process, it nevertheless affords considerable freedom. For example, Step 2, “seal envelope,” may or may not be split into three separate steps, such as “lick envelop,” “press it” and “let it dry.” And this is just one option. Whether or not to specify detailed steps, again, depends on the purpose one may have in mind. If the purpose is automation, one will try to separate steps that can be performed by a single machine. In the case of Fig. 2-1, the first three steps can be performed by a machine. Therefore, a model as in Fig. 2-2 is suitable for that purpose. The things written above may look like simple common sense to many readers. They are not so common, however. Many consultants and managers (including myself) begin modeling processes just because it is in fashion (or maybe because their bosses wish it). The question of purpose is hardly ever asked – and it is rarely precisely answered. It

Fig. 2-2: Mailing process in two steps



results in nice – or sometimes impressively complicated looking – graphics that have no use at all. Then again, there often are very good reasons for process modeling. Maybe the best known reason is for automation using IT. I will not comment on that in this book, but rather will stress such other areas as organization or balanced scorecard. In general, one will model a process if one wants to know what is going on in the business under consideration. Defining the desired information precisely will clarify the purpose.

The rest of this chapter is organized as follows. In 2.1, I will talk about structuring. This means *organizing* the process model. In addition to the graphical displays of Fig. 2-1 or Fig. 2-2, there are strict graphic rules on how to model a process. I call these *languages*, and I will comment on two of them in sections 2.2.1 and 2.2.2.

2.1 Choose a structure

To structure or not to structure: that is the question:…

Not unlike Shakespeare and his Hamlet, I will invest more than a few words to bring us to an answer to this fundamental question, because there is a good deal to be learned in while contemplating the question. The answer will come shortly, but first I want to explain what I mean by "to structure" in the context of process modulation. Everything said will be valuable for either formal process languages or informal ones.

Fig. 2-3 displays a process in seven steps, from "do 1" to "do 7." The process is displayed in an unstructured manner (sometimes referred to as an "all-in-one" approach). From Fig. 2-3, it can be summarized in two steps with appropriate sub-activities. The process from Fig. 2-3 is obviously identical to the process in Fig. 2-4 so long as do $1_{\text{Fig. 2-3}} \equiv$ do $1.1_{\text{Fig. 2-4}}$, do $2_{\text{Fig. 2-3}} \equiv$ do $1.2_{\text{Fig. 2-4}}$, …, and do $7_{\text{Fig. 2-3}} \equiv$ do $2.3_{\text{Fig. 2-4}}$ holds. For a process with just seven activities, nobody would create an elaborate structure. In the case of a process having, say, 700 activities, however, some structure must be applied, lest one needs to use a sheet of paper the size of a tennis court. From this perspective, the choice to structure appears very obvious. In real management projects, though,

Fig. 2-3: *Unstructured Process*

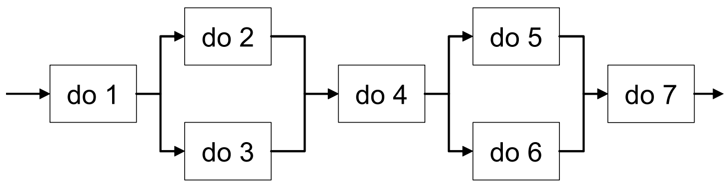
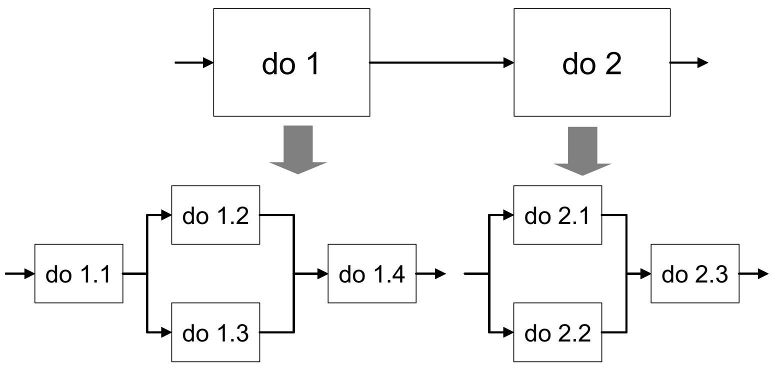


Fig. 2-4: *Structured Process*



unstructured approaches are sometimes chosen. In a project of my own, I was once forced by the client to display a process of around 100 activities in an unstructured way. We had to use a DIN A0 format paper (84.1 cm x 118.9 cm or approximately 33 x 46 inches) in order for the letters to be reasonably readable. Although the result cannot be displayed in this book for obvious reasons, rest assured that it looked pretty confusing. The client rationalized his wish because he wanted to look at one sheet of paper to see the entire process. The process display, in and of itself, was quite useless, but we satisfied the wishes of our customer. In addition, there was another “positive” side effect, which was that our top client saw the process and found it to be “pretty impressive.” Of course, he comprehended nothing that was displayed there, but his reasoning for not understanding it was complexity. “It is easy to see,” he remarked, “that this process is too complex. We have to reengineer.” (cf. chap. 5.5) From this, we obtained a magnificent justification for our future work. I should note, however, that in fact the process was by no means complex. It was actually rather simple.

So far, I have given good reasons for structuring a process. In addition, I should emphasize that structuring helps us to think in structured ways, which is indispensable when dealing with truly complex processes. Not surprisingly, there are special software packages available for displaying processes. Some support structuring, others do not. But I will not comment on software products in this book.

Besides the question of whether to structure or not to structure, one needs to know *how* to structure. There is no standard answer to this question, either, although some software companies suggest otherwise. To establish a standard for it would be like building a standard table of contents into software for word processing. The structure must accord with the purpose one has in mind. Such purposes could, by way of example, be one of the following:

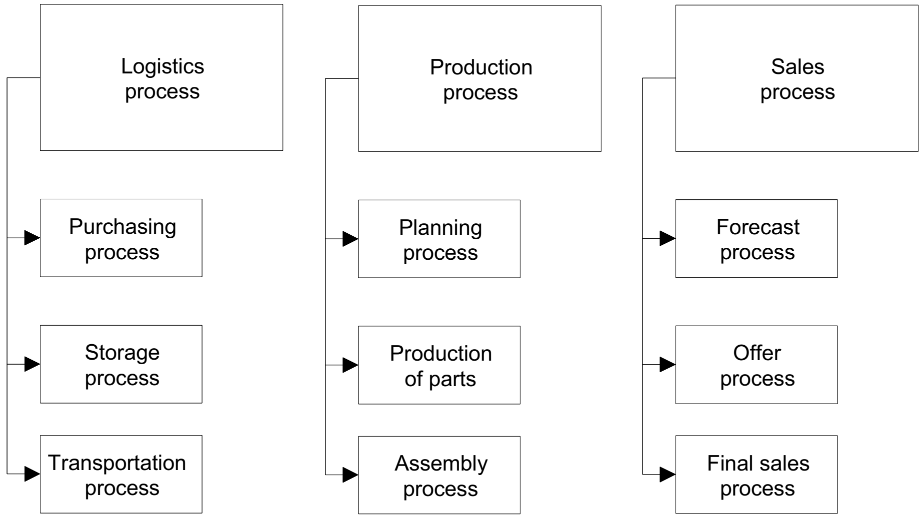
- to analyze the tasks and workloads of organizational parts

- to build a core competency structure
- to create a basis for a profit center organization
- to fashion a new controlling system
- …

If one wants to investigate the workloads of different organizational departments, one will structure the process in accordance with the present organization. (Each activity must belong to one department only.) For the other purposes on the list, one has to structure differently. The last purpose (fashioning a new controlling system) might look odd at first glance, but it is arguably the most important one in a real business situation. For additional clarification, please refer to chapters 3 and 4. A very important thing always to bear mind is that once one has chosen a structure, and the process is therefore displayed in a particular form, there is no easy way to change that structure. There is no one-fits-all structure. That means that a company might need to model its processes anew, even though it had created a model just last year.

Before closing this subchapter 2.1, I will comment on two further methods that are used for structuring. The first approach is displayed in Fig. 2-5. Here, one is considering the (core) processes of a company. These are ordered in a process chart just like an organization is arranged in an organization chart (cf. Fig. 5-1). The company under consideration in Fig. 2-5 has three main processes (e.g., logistics process), and each process has three subprocesses. The details will depend upon the purpose for which the process model is made. Once such a process chart, or process map, has been developed all subprocesses (numbering here nine) will be given to separate experts in order to develop an (unstructured) process model for each. Of course, this is one possible and logical way to structure processes. The method is quite often applied when using the language ARIS (cf. chap. 2.2.2), although the approach is universal. It has an essential drawback, however, because there may be important connections between the subprocesses other than those displayed in the process chart.

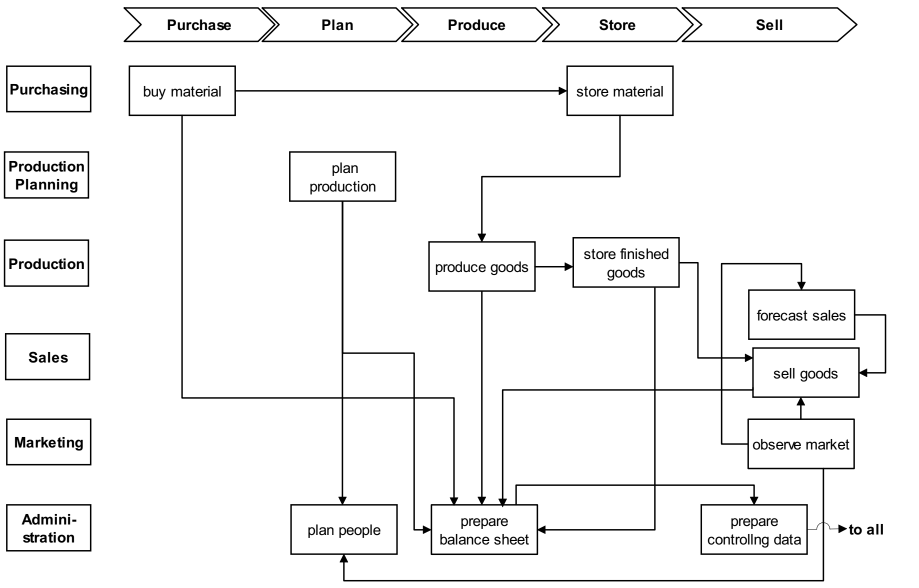
Fig. 2-5: Process chart



(Depending on the goods sold, e.g., there may be an important connection between the "transportation process" and the "offer process" of Fig. 2-5.) These interdependencies will become clear when the details of the subprocesses are worked out. Therefore, the workgroups occupied with the various subprocesses will have to work closely together. Essentially, they will face the complexity of an unstructured process. More often than not, people are fearful of such complex work structures. They begin to ignore the interdependencies and end up with an oversimplified process map. (In section 2.2.1, the examples will show that the "normal" way of structuring does not create such problems.)

The second alternative way of structuring I will comment upon is slightly more dubious, although it is quite often used. Here, the process is displayed in an unstructured manner. The main ingredient is the vertical ordering. On the vertical axis, the departments under consideration are written down. They define vertical lines. Each line

Fig. 2-6: *Process ordered by departments*



bears activities only of the indicated department. For an example, see Fig. 2-6. It is not necessary to look into the details to see that this approach makes a pretty simple process (eleven activities only) appear rather complex. There are two reasons for this. Firstly, it is unstructured. Secondly, the position of each activity is fixed. The second characteristic makes the connecting lines unnecessary long. As a result, such "structuring" (which is not at all what we actually regard as structuring) appears unduly complicated. Upon more rigorous consideration, one can conclude that such approach is plainly wrong. The process of Fig. 2-6 indicates not just *what* is done, but also *who* is doing it. The figure displays the roles and responsibilities (cf. chap. 5.1) in an illogical way. This becomes clear even without reading chapter 5.1. Consider the case of activities that are carried out by two (or more) departments. Where should these be placed in Fig. 2-6?

In summary, such a method makes processes look more complicated than they are, and, more importantly, it is illogical. It might therefore be very difficult to explain why people are using this method. While I cannot read peoples' minds, I must admit that I was personally involved in projects where such a method was used. In those cases, the reasoning for using such method was nothing to be proud of. We used it in order to cause something simple to appear complicated. To expand upon this trick, one might reorder the departments on the left-hand side of Fig. 2-6. Because the connecting lines are fixed, this will transform the display into a bowl of spaghetti. Most executives are then easily convinced that such a "complex" process needs reengineering (cf. 5.5), even though some marginal changes within the process itself could get the job done. The next step, then, is to display the "reengineered" process in a chart where the departments are ordered skillfully. In doing so, the aforementioned spaghetti dinner becomes untangled. Believe it or not, almost every executive will be pretty impressed by this "before and after" picture.

In the beginning I asked "To Structure or not to structure…" Reading this subchapter should have transformed the question into a rhetoric one. Though some people like an unstructured approach, it will never yield any benefit. It makes simple things look complicated.

2.2 Select a language

Processes in business are displayed graphically (as in Fig. 2-1). There is no law saying it must be done in a certain form, and quite a lot of people do it however they like. The main point is that the potential reader – or better readers – will understand it as intended. Sometimes that is easy, and sometimes it is impossible. Therefore, it would seem like a smart idea to have fixed rules for a graphical display. I refer to these fixed rules as a language. It is comparable to real languages, and especially to grammatical rules. (Thankfully, however, these languages are far easier and quicker to learn.) Using certain languages for displaying processes makes it easier to communicate the underlying logic. Furthermore, it forces the creator to stay on the logical path and to develop a concise process model.

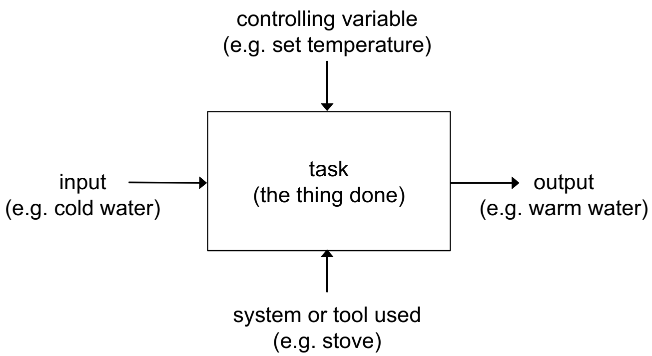
Arguably, Petri nets are the oldest or first process language. They are named after C. A. Petri, who developed them within his Ph.D. thesis in Darmstadt, Germany in 1961. They have been used intensively in the chemical process industry to display technical processes. Today, they are sometimes used by mathematicians. Their use is pretty limited in business today, and therefore I will not comment on them. (However they are practically identical to ARIS, cf. chap. 2.2.2. Mathematically speaking, there is an isomorphism between Petri nets and ARIS.)

In what follows, I will comment on two languages: 2.2.1 is about SADT and 2.2.2 discusses ARIS. The second one of these is probably most often used today. It is therefore indispensable to comment upon it. SADT, by contrast, is maybe a little bit out of fashion, but it does have certain advantages over all other languages.

2.2.1 SADT

SADT stands for "strategic analysis and design technique." The rules are pretty simple. In Fig. 2-7 there is a box. From the left-hand side there arrives an arrow denoting the input. This is the initial state. Inside the box, a task is written down. This action will transform the input (initial state) into the output (final state). The output leaves the rectangular box always on the right-hand side. The incoming arrow on the top denotes the controlling variable. It is a guideline how the task should be done. The arrow approaching from below indicates the system or tool used. In the business world, this is quite often a computer system or software. In production, it can be a machine. Outside of IT, however, the arrow from the bottom is rarely used. The main point about SADT is that the sides of the rectangular box are allowed for certain variables only. An unambiguous advantage is that

Fig. 2-7: *SADT rules*

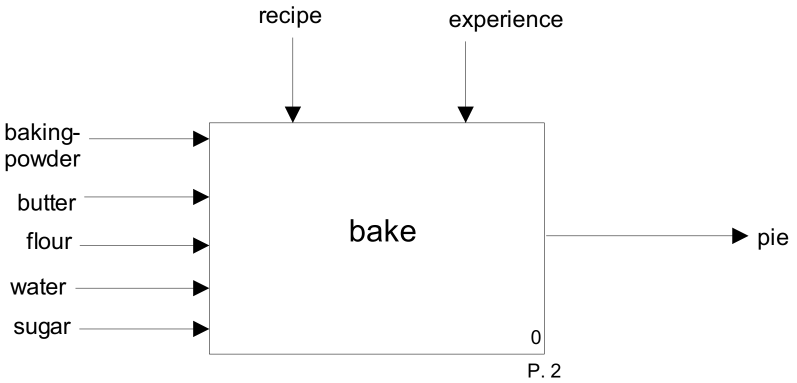


a SADT diagram is very easy to understand, because inputs, outputs, and controlling variables are clearly distinguished. The creator of a SADT diagram is compelled to decide between the different variables that support logical thinking.

A quite general remark for all languages is that each task begins with a verb. Examples are: boil water, sell goods, or calculate profit. It sounds like a superfluous remark, but, for whatever reason, people are fond of using nouns instead of verbs for tasks. Instead of “sell,” for instance, one quite often sees “sales.” Not only is such mixing ugly from a language teacher’s perspective, but using a verb is far more precise. In writing “sell,” one makes clear what is being done. Writing “sales” only states who is doing something. One may assume that sales is selling something, but the sales department is most likely doing many more things in addition to selling something.

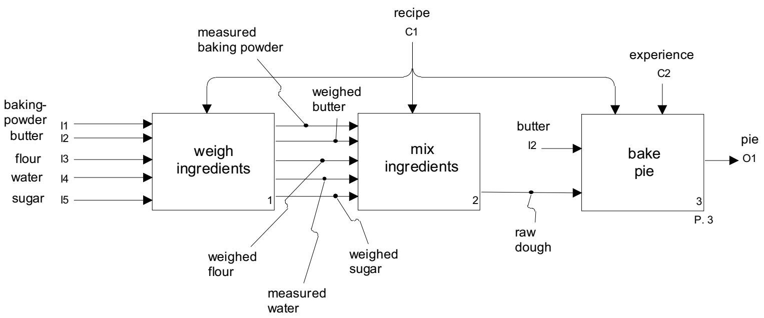
In order to become more familiar with SADT, I will first give an everyday life illustration and then one from the real business world. The daily life example is baking a pie. On the top aggregation area, the baking looks like the diagram in Fig. 2-8. It is obviously an SADT diagram. All inputs are coming from the left and the activity "bake" transforms the ingredients into the output "pie." Even on this top

Fig. 2-8: *Baking a pie top view*



view, many things can be seen. This pie contains neither eggs nor yeast. Furthermore, there is a recipe driving the process as a controlling variable. But this recipe is not idiot-proof. In addition to the recipe, one needs "experience." In order to obtain more information about this particular baking process, one may break the activity "bake" of Fig. 2-8 into three sub-activities – "weigh ingredients," "mix ingredients" and "bake pie" – as done in Fig. 2-9. The process of baking a pie becomes already clearer in Fig. 2-9. One sees for example that "experience" is necessary only for the last step in "bake pie." The weighing and mixing must be described in detail in the recipe. Moreover, the mixing is done in an industrial rather than household way. When mixing ingredients at home, one may end up with dough too dry or too wet. One must add a bit of extra water or flour. But this is impossible in the process of Fig. 2-9. There, the only choice is "measured water" and "weighed flour." From that, one can see that this is a typical industrial process. The ingredients are weighed precisely, and it is not left to the will of the machine operator

Fig. 2-9: Baking a pie in three activities



as to how dry or wet the dough will be.

The structuring of the baking process into these three particular activities is of course arbitrary. The choice of activities depends on the purpose for which the process is modeled (cf. chap 2.1 "Choose a structure"). In moving from Fig. 2-8 to Fig. 2-9, however, one has to respect some fully logical rules. In Fig. 2-8, there are exactly five input variables coming from the left. Exactly the same variables enter as external inputs in Fig. 2-9. The same is true for the output ("pie") and the two controlling variables. It is absolutely forbidden to "invent," for example, "some eggs" in Fig. 2-9. In order to describe the process of Fig. 2-9 in further detail, however, one may split the three activities into useful sub-activities generating three or more new subprocesses and so forth. The degree of detail depends on the information one wants to present using the process model.

To close this section, I will give an example from a real business situation. It will demonstrate the use of process modeling. Some time ago, I had an assignment to establish a well-defined "make or buy" process for a pharmaceutical company. Make or buy decisions are more complicated in the pharmaceutical world than elsewhere. There are many more regulations. Even slight changes in what is bought or done inside the company may have critical legal consequences due to

***Fig. 2-10:** Process to decide on make or buy: top view*

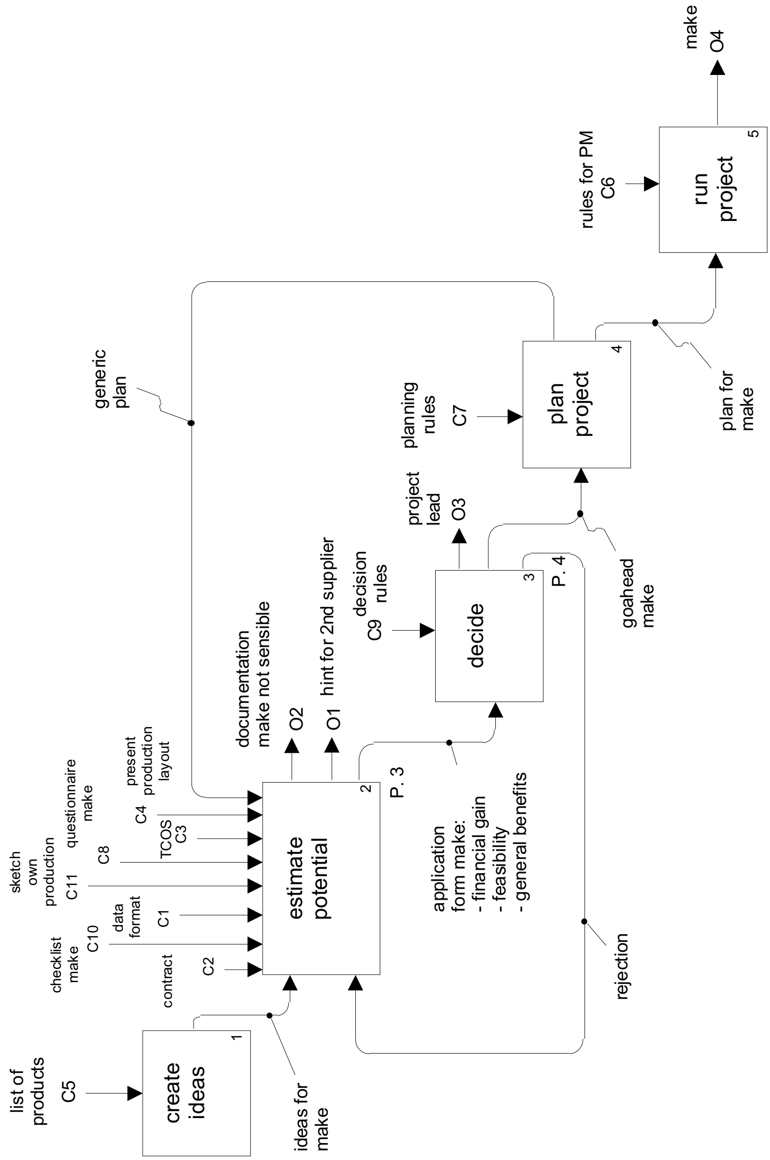


Fig. 2-11: Process to decide on make or buy: estimate potential

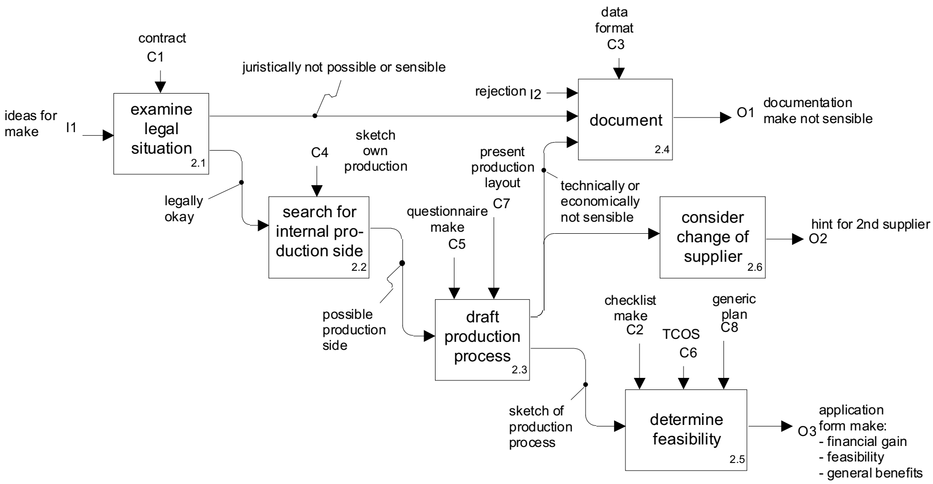
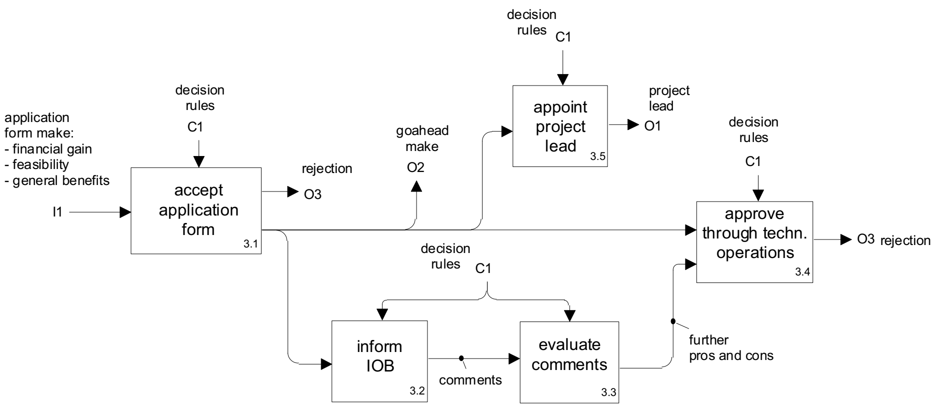


Fig. 2-12: Process to decide on make or buy: decide



the patent and contractual situation. Furthermore, almost every change implies a testing period for the changed product, and that will easily consume one year. Therefore, one must think the matter through very thoroughly before deciding to make or buy. A change may bring cost savings, but one has to invest a lot into the process of change. In order to establish a reasonable make or buy process, I started to interview several people involved in the make or buy process. From that, I obtained an idea as to the necessary tasks to be performed. I summarized my findings in a first version of the five SADT diagrams of Fig. 2-10. This gave me a one-page picture that could be discussed with the management and lead to further improvements. Please note that it is very difficult to imagine discussing this important process with the management in any other way. Moreover, the strict SADT rules forced me to be concise. Although it is not so important for the reader to understand or follow completely the process displayed in Fig. 2-10, the diagram should immediately make another advantage clear. Several outside controlling variables (and normally also inputs) are necessary. Consider, for instance, the central activity "decide" in the middle of Fig. 2-10. Obviously, one must decide at some point in the process. SADT forces a controlling variable for this activity. Here it is "decision rules." The immediate question is: "Do they exist? Is there, for example, a piece of paper containing them?" By asking such questions, it will become clear that everything necessary for running the process is available. The important step "estimate potential" (= estimate the net financial gain from the decision on make or buy) has numerous triggering controlling variables. This is complicated and may need some further clarification. It is displayed in Fig. 2-11 (please feel free to ignore the details). In Fig. 2-12, the same has been done for the activity "decide."

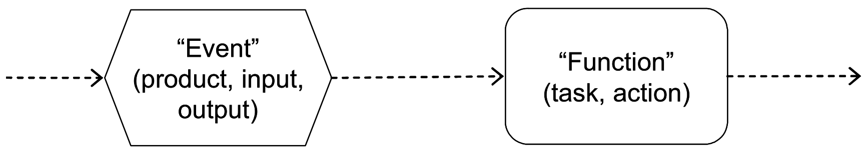
Discussing business processes as suggested here yields an additional advantage. Any process modeling states what is done rather than who is doing it. For obvious reasons, one has to decide "what to do" first. Talking about a processes in such a free manner rather than using a process language encourages people to think of the "who" all the time. This is understandable psychologically. Who is doing something may have severe consequences for the careers of all people involved. Because the "who" is personally so important, people tend to forget about the process itself. The way shown here circumvents this problem. (The question of "who is doing it" will be answered in subchapter 5.1 "Define roles and responsibilities")

2.2.2 ARIS

The second language I will comment on is arguably the most common one for business process modeling. ARIS stands for "architecture of integrated information systems." As the name suggests, it is mainly used in the IT world. There is some confusion surrounding ARIS in that there exist both a language ARIS and a software ARIS. The language ARIS was developed by A.W. Scheer. The software is a commercial product of IDS Scheer AG, Germany. The main use of the software ARIS is for displaying processes written in the language ARIS. The process language ARIS and the identically named software are independent in principle. Because this book is not at all about commercial software products, I will focus on the language ARIS.

As in any such language, there are inputs and tasks in ARIS. Any process transforms inputs into outputs by doing something. This is generally referred to as a "task," but in ARIS it is called a "function."

Fig. 2-13: *Principle of ARIS*



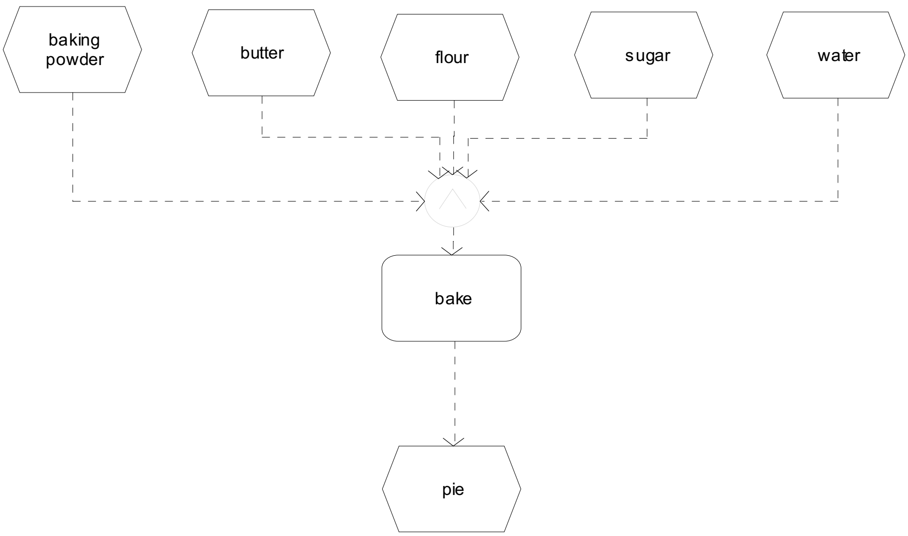
The inputs and outputs are "states," which are termed "events" in ARIS. The basic principle is displayed in Fig. 2-13. In addition to the naming, there are just two rules in ARIS. The event is always in a hexagon and the function is always in a rounded rectangular box. There are no rules as to from which side the events must enter or leave the function. Of course, the principle rules for processes will also hold for ARIS. The function must start with a verb, and an event must be followed by at least one function (but never another event). Violating either rule is illogical.

There are three useful operators in ARIS:

∨ OR operator (one or both)
∧ AND operator (all together)
⊗ exclusive OR (either, not both)

The use of these makes some otherwise ambiguous process models unambiguous. As an example, I have translated “Fig. 2-8: Baking a pie top view“ into ARIS (Fig. 2-14). Using the AND operator makes clear

Fig. 2-14: *Baking a pie in ARIS (top view)*



that really all ingredients are used. With the present list of ingredients the AND operator does not really lead to more clarification, but, if sugar and honey were on the list, it would be less clear whether sugar or honey should be used as alternatives or both simultaneously. The ARIS process is structured here in the same way as I suggested in the section on SADT. As mentioned earlier in the subchapter about structuring (2.1), another method of structuring is quite often used in ARIS. In this case, one starts with a picture of the core processes (cf. Fig. 2-5 on page 17), and each process is modeled independently.

To summarize, ARIS is a complete language that can be used to model any process. However, it has two essential drawbacks, if one compares ARIS to SADT. Firstly, it is a little bit clumsy. This is easily seen if one compares Fig. 2-14 with Fig. 2-8 on page 22. The content is obviously identical. However, Fig. 2-14 uses much more space. This is because all inputs and outputs are in hexagons. Secondly, ARIS does not distinguish between inputs and controlling variables as does SADT. Normally, controlling variables are simply ignored in ARIS – as I have done in Fig. 2-14. The tremendous benefit of using controlling variables will become clear in chapter 3, "Balanced scorecard."

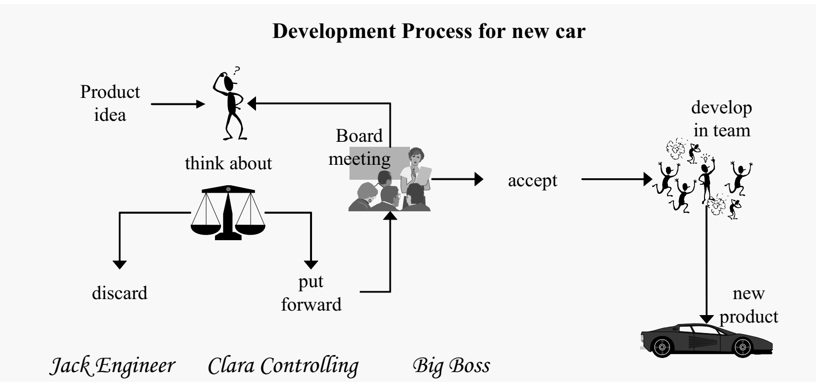
The main advantage of ARIS is that it is so commonly used (at least in Europe). If one wants to introduce a new enterprise resource planning (ERP) system in a company, one has to model the business processes. Essentially, this must be done in order to see which task can be accomplished, or is supported, by which part of the ERP system. In principle, any modeling language can be used. There is even a slight advantage in using SADT. This is because SADT denotes the supporting system by an arrow from below (cf. Fig. 2-7 on page 21). At least in Europe, ERP systems made by the software company SAP are very common. Although IDS Scheer AG (the company producing the ARIS software) is not part of SAP the two firms do have some ties. When modeling business processes with the language ARIS while using the software ARIS, it is easy to translate the result into the requirements for an ERP system from SAP. Therefore, modeling processes in ARIS and using the software by the same name is highly recommended if one wants to introduce an ERP system from SAP. If the business process is modeled for any other reason, however, I see scarcely any advantage for ARIS over SADT.

2.3 Use of brown papers

In this subchapter, a very informal way of modeling processes will be discussed. Although arguably the method was "invented" by Gemini, a consultancy, many companies use the method extensively. Because it is an informal language, the details will vary. The basic purpose of creating brown papers is the same as in any other language. One wants to describe or better display how something is done. The setup is very different however. To see how it operates, I will give an example.

In an automotive company, one wants to know how the development process for new models is conducted. In order to get the information, one invites selected people to a workshop. (Maybe some people from

Fig. 2-15: *Brown paper*



R&D, someone from controlling, production…) These should be people having broad knowledge. The invitation encourages them to think in advance about important details of the development process from their perspectives. Furthermore, they should bring "requisites." These are things, forms, guidelines and the like having to do with the process under consideration. At the beginning of the meeting, a big sheet of paper ("brown paper") is fixed to the wall. Typically, it is something like one meter in height and several meters wide. (Most people are familiar with packaging paper on rolls. It is brown in color and is one meter by 10 meters.) On this paper, *all* people will together "draw" or "paint" the process. They may use their requisites as references. Furthermore, pictures or pictograms are used. (e.g., a telephone symbol instead of the words "somebody provides this information by phone") After a couple of hours, something like the picture in Fig. 2-15 will have been created. Of course, a real life brown paper will contain many more details than Fig. 2-15. While brown papers may look a little bit like a kindergarten art project, they have powerful advantages (and disadvantages). The benefits can be summarized as follows:

- The group will accept the result easily.
- Participants are highly motivated, because everybody can contribute.
- It will attract attention and constructive comments from other groups.
- The humorous atmosphere will foster creativity.

In business, reaching a result and obtaining acceptance of a result are two very different things. Normally, the latter of these is much the more time-consuming and difficult. With brown papers, the acceptance is very easy. At least those in the group that created it are proud of their product. (This is also accentuated by adding the signature of each group member to the drawing.) Motivation is normally both broad and deep because everybody is able to contribute at least something. Inasmuch as a brown paper attracts attention, other people feel encouraged to comment on it. A typical practice is to display the brown paper in a place many people visit (e.g., the cafeteria). As it is an eye-catcher, people naturally will look at the drawing and think about it. This last point may be the most important one. Creativity is key to success for many businesses. There is a lot of research going about how to foster creativity, and there is still much to be gained in this area. One generally accepted way to foster creativity is through humor. Laughing people are more creative than unhappy ones. Because brown papers are a bit like kindergarten, people may approach them light-heartedly at first but then think very seriously about what is going on there.

Besides these striking benefits there are also concerns. Typically, people ask questions like this:

- How is it possible to model in a precise and logical way with such an informal language?
- How can I share the results with people far away?
- How is it possible to file the results for future reference?

The immediate answer to all of these questions is that it is not possible. For a complicated process for which finding the logical path is essential, one should use a formal language. Sharing results with people far away is difficult because a piece of paper of such size must be mailed as a parcel. For the same reason, storing it is complicated. However, some people think one can overcome these drawbacks. One can take a digital (high resolution) picture of the process model, for instance, or ask a secretary to create an electronic document by redrawing the original brown paper using a presentation program (e.g., PowerPoint). Formally, this will solve the problems of sharing and storing, but it also will destroy the very nature of a brown paper. Brown papers are authentic and bear the "fingerprints" of their creators. They are impressive because of their size. All of this vanishes when someone creates a copy.

To summarize the text above I will give a guideline when one should use brown paper and when one shouldn't:

Brown papers are ideal for

- resolving psychological conflicts.
- groups that are inhomogeneous and with little experience in formal process modeling.
- drawing out hidden arguments.
- motivating a group to think about processes.
- creating a result that will be widely accepted.

Brown papers should not be used

- if the aim is to pinpoint technical shortcomings.
- as a basis for introducing a new IT system.
- as a basis for ISO certification.
- to model an extremely difficult or complicated process.

3 Balanced scorecard

Almost any reader of this book will probably have heard of balanced scorecard (BSC). It is one of the best known among business buzzwords. Search engines like Google yield over seven million entries for the term “balanced scorecard.” Thousands of books and articles mention it, so it cannot be true that there is no reasonable literature about BSC. Indeed, the original articles by Kaplan and Norton published in the *Harvard Business Review* in 1992 and 1996, respectively, contain much useful information. The same cannot be said about most books and articles published later. By and large, these make the concept too complicated and rarely come to useful conclusions. Furthermore, I have heard many managers talk about balanced scorecard even though they have scant knowledge of what it is. It thus deserves here the attention of an entire chapter.

3.1 The general problem

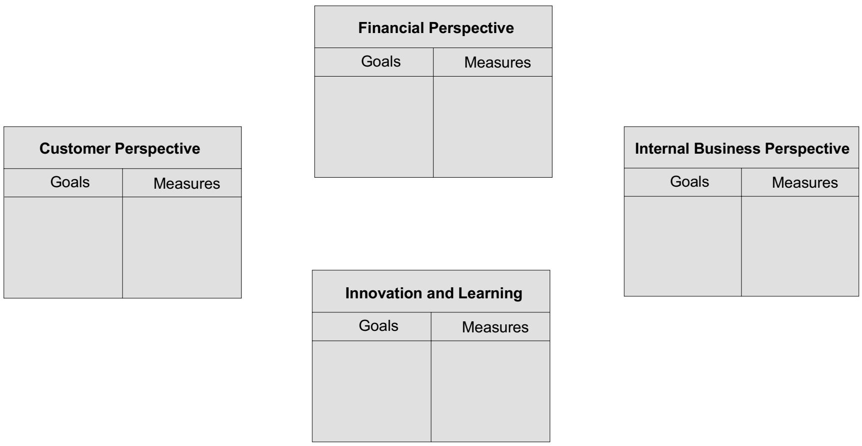
For someone running a business, it is necessary to have measures for judging success or failure. I call such measures controlling variables (for more on this, see the next chapter). Most of these are more or less obvious. Profit generated is obviously a useful measure or controlling variable. Especially in accounting, there are numerous such variables, including return on investment (ROI), cash flow, economic value added (EVA) and many more. “Pocket MBA”-type books are full of them. The main question of is: How do I find a complete and useful set of variables? If all these variables show proper values, it would seem, then the business must be running fine. One might even conclude that profit is all that really matters. But one would be a bit too quick in making such a judgment. For example, it is possible to pour loads of capital into a business in order to keep the profit constant. Obviously, though, doing so would destroy value. While profit is a good accounting concept, businesses run and grow on cash flow. Another problem with profit is that the contributions to profit from various departments such as controlling or personnel are difficult to calculate. It is no simple matter to find a complete and useful set of controlling variables that one may call a balanced scorecard. Yet almost everyone will agree that it is necessary to find it. The question of just how to do so is another matter. Some claim that Kaplan's and Norton's balanced scorecard approach is a good one. And good it may be, but it is also complicated. This subchapter will in fact make clear that there is only one way to find the necessary variables. This way is called the balanced scorecard approach.

Another requirement for a complete and, especially, reasonable set of controlling variables has to do with their timely expression. Normally, of course, one wants to improve the future (because the past cannot be improved!). Unfortunately, all measured values of controlling variables come from the past. This gives rise to two problems:

- By the time that data is reported it is already too late to do anything about the state of affairs they measured.
- One can only guess as to what to do better in order to avoid bad data in the future.

Therefore, Kaplan and Norton said: "Controlling with measures from the past is like steering a car by looking in the rear mirror only." This last problem has its root in causality. There is, then, no real solution for it (with the possible exception of time travel). The trick to circumvent the problem is to use variables that can give early warnings of future failures. Consider an airline. Its main goal is to make profit, and this is closely related to how many passengers will fly. Punctuality has no *direct* relation to profit. If arrival and departure times are poor today, profit may still be okay tomorrow. Should poor punctuality continue, though, fewer passengers might fly that airline, leading to lower earnings next year. Kaplan and Norton summarized this as shown in Fig. 3-1. Prior to their work, only the financial perspective had been taken into account. The aforementioned variables – profit, ROI, EVA and the like – belong in this category. But, even if the financial perspective looks okay today, it may worsen tomorrow if the customer perspective, the internal perspective, or innovation and learning do not show proper values. Punctuality may belong in the customer perspective category. The internal perspective is related to internal processes, and, among other things, costs definitely belong in this category. So, too, might a measure like scrap rate in a manufacturing process. Innovation and learning is the category that looks most

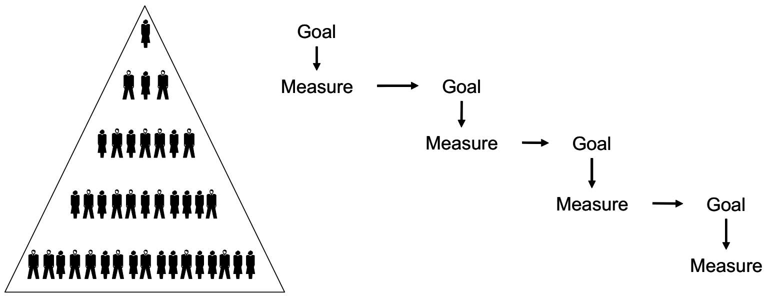
Fig. 3-1: *The four perspectives of BSC*



obviously into the future. Examples for this category are product cycle time or the slope of learning curves.

Under each perspective in Fig. 3-1, there is a column for "goals" and a column for "measures." This should make clear that one needs a measure (e.g., €, $, %) in addition to a goal. The goal may be to improve the profit. The measure may be by €10 million. If someone wants to introduce a balanced scorecard for a company, he or she has to fill in the four perspectives of Fig. 3-1 with goals and measures. This must first be done for the company as a whole. Then it must be broken down for each business unit and, eventually, for each person (compare with Fig. 3-2). This "translation" is absolutely necessary and far from being trivial. Consider a big trucking company. The firm as a whole may have the goal to improve its punctuality. At first glance, it seems

Fig. 3-2: *Translating the vision*



to be clear what it means for the individual truck driver. However, what part of "punctuality" belongs to the truck driver and what part to logistics planning? Figuring the contribution of the personnel department is even trickier. More often than not, breaking down the measures does not work. There are two reasons for this:

- The suggested top-level goal cannot be broken down for principle reasons. Another goal must be chosen.
- It cannot be broken down within the existing organization of the company. Then another organization must be chosen.

The second point clarifies the close relation between BSC, controlling, and organization. There is no panacea to avoid the problem, although some approaches may suggest otherwise. From the financial perspective, quite a lot of companies choose a sufficiently high ROI as their goal for the top level. A typical number might be 20%. (This means the invested capital earns an annual return of 20%.) ROI is definitely a reasonable variable for most shareholders. And they build the top level of a company. Breaking it down to business units or departments seems to be trivial, at least if the unit under consideration is considered a profit center. (Each unit has its profit and invested capital. And the quotient of these two is the ROI.) Although this is done quite often, it is far from being reasonable. The profit for each unit is easy to determine. However, a reasonable interest rate is hard to set. For a big conglomerate, 20% ROI may be reasonable. If a real estate unit belongs to that conglomerate, however, it will never achieve 20% ROI. In contrast, a business unit in consulting might easily reach a three digit ROI. Therefore, each unit needs its individual measure for an interest rate and the breakdown becomes virtually impossible.

To summarize, there are two steps in creating a balanced scorecard:

- Choose a set of controlling variables that is complete and have an impact on the future (compare with Fig. 3-1).
- Break them down in a logical process that eventually reaches all the way to the individual worker (compare with Fig. 3-2).

From this short summary, something else becomes clear. The balanced scorecard approach is in some sense obvious. It becomes clear if one takes the negation of the two summarizing points above. Nobody wants to choose an incomplete set of controlling variables that have no influence on the future. And if they are not broken down to the individual worker, then nothing will change. In saying this, I do not mean to diminish the work of Kaplan and Norton. While we may now regard the balanced scorecard approach as common sense, it was not so common prior to the work of Kaplan and Norton. Therefore, they should be acknowledged as the people who made balanced scorecard happen.

3.2 An example of BSC

The previous subchapter summarizes the principles of balanced scorecard. This subchapter offers an example. The intention is not to write a complete report about a successful BSC project, because such a report would fill over 100 pages and yield scant learning. My goal is to expand upon the previous subchapter by restating it in other words. I particularly want to stress the difficulties and problems that may arise.

The example I have chosen is German rail. It will be simplified in order to avoid unnecessary complications. The example may not be very different from any other big railway company. Because it does not make sense to have several independent rail networks within one country, rail companies tend to be monopolistic and quite large. Many rail companies have roots as state enterprises rather than private companies, moreover, and state enterprises have very different controlling systems than do private companies (sadly, they usually have none at all.) These two facts support the idea of introducing a rigorous balanced scorecard system in companies such as German rail. The place to start is with thinking about the goals and measures of Fig. 3-1. What variables determine whether German rail (as a whole company) is performing well or not? A possible answer is shown in Fig. 3-3. Such goals and measures must be derived from a couple of workshops with top management. They should be inferred from the

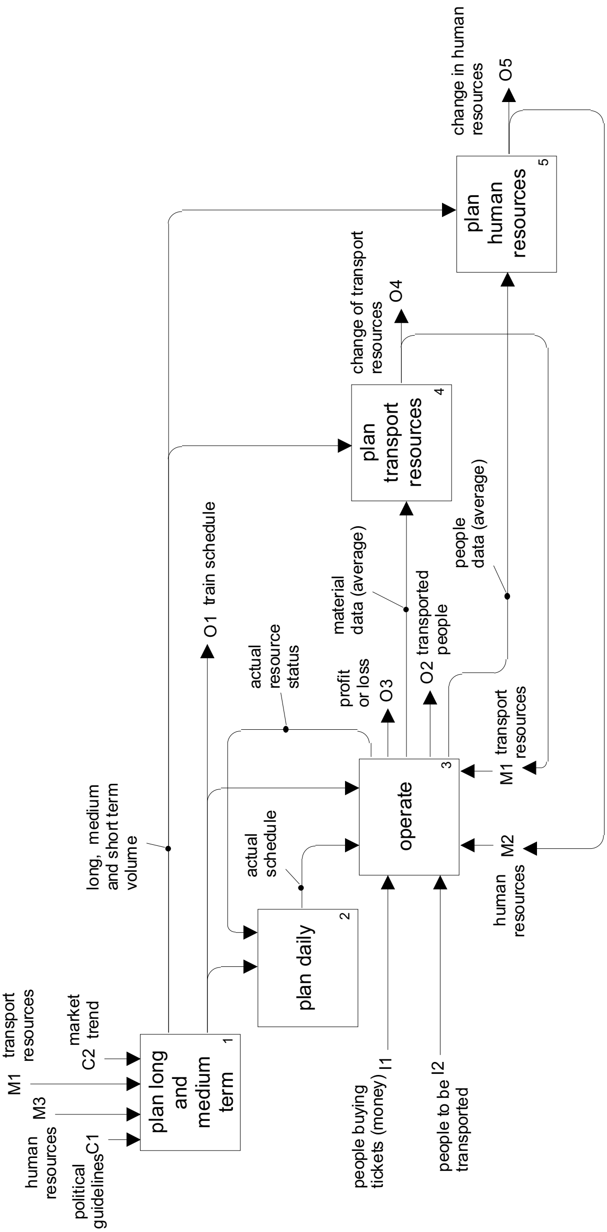
Fig. 3-3: *Example of goals and measures*

	financial perspective	customer perspective	Internal perspective	innovation and learning
goal	being profitable	being punctual	being cost effective	becoming fastest national transport company
measure	profit > …	punctuality > …	€ per km and person < ….	travel time shrinks by … min. per 100 km per year.

company's strategy. (Fig. 3-3 shows what I think is reasonable.) Such top-level goals and measures are, by and large, derived quite easily, and especially in comparison to what follows. However, they are far from being trivial. Each one needs an exact and useful definition. Consider, for example, punctuality from the customer's perspective. One may take delay time divided by total travel time as a relative measure that is probably sensible. (German rail actually chose "percentage of trains which are on time," where "on time" is defined as a delay of five minutes or less.) It is important to take the customers' perspective. From their point of view, individual train delays have little meaning. Customers are interested in the punctuality for their entire trips. (If one has to change trains, a delay of five minutes can easily become an hour.) For each additional variable above, similar considerations must be taken into account. Once the goals and measures have been agreed for the top level (Fig. 3-3), the next step is to break these down at the lower levels (compare with Fig. 3-2). Such translation of the vision eventually leads to personal scorecards. While of course everybody inside a company has to know his or her personal measures, one should note that goals and measures apply to tasks rather than to people. Tasks are carried out by individuals. (Who does what is a question of organization. See subchapter 5.1.) So, one has to break down the goals and measures into tasks rather than people. This makes it clear that one needs a list or, better still, a structure of tasks rather than an organization chart. How does one get a reasonable description of tasks? The description of tasks is a process model, which is discussed in chapter 2. (At this point, it is impossible to go on with BSC without knowing about business process modeling.)

In the example under consideration here, the process model is displayed in Fig. 3-4. The process is structured by departments. This means that each of the five activities in Fig. 3-4 belongs to one department only. Although thoroughly understanding the details is not now essential, I will briefly explain the process. The central activity is number 3, "operate." This is where the trains are run and people are transported. All other activities manage this central operation. First,

Fig. 3-4: *Process of German rail*



one needs a time schedule for the trains. The timetable is created in the "plan long and medium term" activity. This activity is very important from a marketing point of view. It determines where and when the trains should run. In a world without any delays, an annual plan would be enough. In the real world, there are delays, accidents, and so forth. Someone has to decide what to do in such cases. This is the content of the "plan daily" activity. The two remaining activities of Fig. 3-4 are less time dependent. These are about planning the resources in the medium and long term. Activity 4, "plan transport resources," is for planning the trains and all other rolling resources. Human resources are planned in activity 5. Taken together, these activities are German rail's business process. If done successfully, they should guarantee success for the entire company. Success of the entire company is measured by the goals and measures of the table in Fig. 3-3. Therefore, one has to find a connection between these goals and measures and the activities of Fig. 3-4. Consider punctuality. Which activity will create it? Because delays arise daily, the "plan daily" activity must be responsible. This activity should, therefore, have an additional controlling variable, "punctuality > …". This controlling variable could be added to the top of the box of activity 3 in Fig. 3-4. From this, it becomes clear why SADT is the best process language for BSC projects. The measures are the controlling variables for each activity, and this can be indicated by the controlling variables of SADT.

The same process as has been worked through for punctuality must be carried out for each other measure. If this is done, one has to take care of the sub-activities. For a company the size of German rail, the process of Fig. 3-4 is a very rough model. A reasonable degree of detail would require at least five sub-activities for each activity and then about five sub sub-activities for each sub-activity. In doing so, one will create 125 activities on the lowest level. All these activities need proper controlling variables, and from this one may estimate the huge workload required. The job is by no means straight forward. Problems beckon at every corner. Some typical problems in assigning measures to activities include:

- One does not find an activity really connected to the measure.
- Several activities significantly influence the same measure.

The simplest explanation for the first problem could be an error: an activity is missing in the process model. Another reason might be that such measure cannot be influenced although it is in some sense important. Depreciation provides a good example. In some businesses, huge long-term investments are necessary, and depreciation accounts for perhaps 90% of all costs. Because costs are important for almost all businesses, depreciation is an important measure. At least in the short run, however, it usually cannot be influenced by any activity. In such cases, one has an important variable but has no control over it for principle reasons. Unfortunately, there are some variables that are beyond one's control.

The second problem (multiple activities influencing the same measure) is also unacceptable from the viewpoint of proper controlling. Especially when the business is badly run, it is impossible in such case to find the person accountable. If two people are accountable for one thing, it is the same as if nobody is accountable (see also subchapter 5.1, "Define roles and responsibilities"). Avoiding this problem is easy if one can "split" the measure. In order to see what this means, consider "profit" in our example. It is definitely an important measure here and for most other businesses. However, in looking at the process model of Fig. 3-4, at least three activities might be blamed for decreasing profit. "Plan long and medium term" might have scheduled trains that no one wants to ride. "Plan transport resources" might have ordered too many trains and created unnecessary costs. "Plan human resources" may call for too many people, which will raise cost for the same reason. However, this problem is easily solved. Profit equals revenue minus cost. Cost can be split into labor cost and cost for "hardware" (trains, etc.). Thus, profit can be split into three parts and each part has a unique connection to one of the activities under consideration.

So far, this looks like a simple solution to the second problem. But such splitting will not always be successful. In some cases, it is a question of organization. To see this, consider the cost for trains. In the paragraph above, I suggested to assign accountability for it to activity 4 of Fig. 3-4 (plan transport resources). However, the costs of trains include both the costs for original purchase and the costs for maintenance. While maintenance and purchasing are very different activities, their respective costs are closely related. One may buy cheaply and accept high maintenance cost or vice versa. This is a reason to favor life cycle cost. Once accepting life cycle cost as the only reasonable controlling variable, accountability for purchasing and maintenance must be in the same hands. One has to organize roles and responsibilities in a proper way in order to have a successful BSC. Note that this problem is not obvious from looking at the process model of Fig. 3-4. Only the sub-activities will reveal who is responsible for maintenance.

The above problems stress the tremendous source of workload in a BSC project. By assigning measures to sub-activities, one may find out that reorganization is necessary. In doing so, one has to model the process once more. Then, one must start with BSC almost from scratch. If it is found that a measure cannot be influenced by any activity, one needs to choose a new measure, which means that most of the previous work was in vain. Such problems typically occur several times in BSC projects.

This shows that introducing BSC is a huge amount of work. There is no other choice, however, if one is to have a reasonable controlling system. (The next chapter discusses the problem that many companies do not have proper controlling. One reason for this should now be obvious.) On the other hand, if one does have a satisfactory controlling system, one should think twice about starting with a BSC project. A failed BSC project will probably do more harm than good. If one has good reasons for starting a BSC project, then a workload estimate should be performed in the beginning in order to avoid unfortunate surprises in the end.

Two mistakes occur quite often after the decision to start a BSC project:

- The BSC project is regarded as an IT project.
- Top management is not willing to accept its personal workload.

The first mistake stems from the fact that BSC has to do with controlling, and controlling departments are often also responsible for IT. Furthermore, some IT tools are designed for introducing a BSC. Such tools may be helpful, but they do not reduce the workload discussed here. Once the planned BSC project is given to the IT department, too much is expected from the people there. Deciding about the company's goals and measures is definitely a task for top management. The same is true for questions of reorganization. A design for BSC is also a design for the general management of a corporation. The designer must be the general manager.

The second mistake is in some sense just the flipside of the first. In such cases, people correctly realize that BSC projects belong to the top management. While many executives are keen to start an important project, they are willing to participate in only one or two meetings. As soon as the real work begins, they tend to delegate. But top-level decision cannot be delegated. In so doing, one ends up with the same problem as discussed in the last paragraph.

One may conclude from the above that there are very few positive examples of a complete BSC in a big company. At least in my opinion, that is definitely true. Some people go a step further by saying that BSC is of no use because it is essentially impossible to make the system work in reality, and some even consider it a money machine invented by big consultancies. However, BSC is far from being a gimmick. As stated earlier, it is the only reasonable way to find proper controlling variables.

Instead of introducing BSC to the entire company, it may also be considered in micro versions. For example, the head of a department of 100 people has to think quite often about goals and measures for his or her subordinates. BSC logic is very helpful or even indispensable in assigning such goals and measures. (Of course, having a BSC for an individual department will not improve the controlling of the entire company.) Because the logic of BSC means that goals and measures are derived rather than just set, people will easily accept their personal goals. These are not established by the boss but rather arise as a logical consequence of the goal for the entire department.

4 Controlling process

The previous chapter showed how to derive proper controlling variables using balanced scorecard. It should now be clear whether and where measures such as "punctuality," "profit," "return on investment" or any of numerous other possible choices are suitable indicators for measuring performance. Once such goals and measures are set, the controlling process can begin. This chapter discusses how the controlling process works. There are very many books on operative or strategic controlling, and this chapter is intended as a complement to them. I will not touch here on accounting, standard controlling approaches or IT tools.

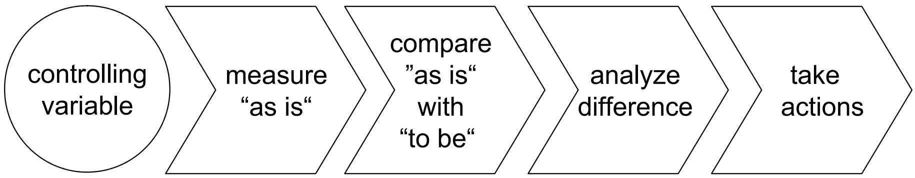
This chapter discusses basic steps of controlling. Although these may look trivial at first glance, examining such basic steps allows one to identify basic problems and mistakes that are quite often overlooked. The chapter concludes by showing that controlling is sometimes impossible for fundamental reasons. This fact is sometimes overlooked or, more strikingly, ignored.

4.1 The four basic steps

The basic idea of controlling is to see if reality is in accordance with the goals set. If it is, then everything is fine. If it is not, then some action must be taken in order to reach the goal. Engineers refer to this approach as a "feedback circuit." Indeed, controlling is nothing but a feedback circuit. In contrast to engineering, though, no advanced mathematics are involved here. Some basic problems with controlling start at the linguistic level, since the verb "control" has essentially two meanings. The first sense is that of "to control the room temperature." This is done with a feedback circuit. If the temperature goes above a certain point (=set measure), then the air conditioning switches on and cools the room (=counteraction). This is the sense of controlling as it ought to function. But there is also second meaning, in the sense of, for example, when a new boss "takes control of a company." In that meaning, the boss determines what is to be done. This implies nothing about a feedback circuit. This linguistic difference should be clear to every high school graduate, but some people *intentionally* mix the two. This leads to self-promotion of the controller and the controlling function in a company. It may sound odd, but I am personally convinced that such "mix-up" is the root of most problems in controlling.

In correctly defined controlling, the four steps in Fig. 4-1 must be considered. The controlling variable has been derived in chapter "3 Balanced scorecard." One may have something like net income in

Fig. 4-1: *Controlling process*



mind. The first step is to measure the actual value (e.g., last month's net income). In the second step, the actual value is compared with the planned value (i.e., compare actual net income with planned net income). If there is a difference between the "as is" and "to be" values, this must be explained. This is done in the third step, "analyze difference" (e.g., by asking "Why is the profit so low?" or "What should be done in order to raise the profit?"). In the last step, actions or, better said, counteractions must be taken in order to reach a state where "as is" equals "to be." In the following paragraphs, I will comment on each step in more detail.

With regard to measuring the "as is," two questions arise: "How often should it be done?" and "How should it be done?" The first question concerns the "frequency of controlling." It is important for all steps. Its importance merits it a separate subchapter (4.2). Measuring the "as is" can be done by the person performing the process, by an extra person, or by an automated procedure. The latter way is very common in today's IT world. In any case, such measurement must not disturb the process itself, because one wants to know the true value. The importance of the aforementioned linguistic mix-up will now become apparent. If a person feels that he or she is being checked up on, he or she will do everything possible to make the measured value look good. Such measurement, then, is obviously not very useful. To avoid this problem, some people try to make more or less secret measurements. Depending on the country's laws, this may even be illegal and, in any case, surreptitious measurements involve serious ethical concerns. Importantly, measuring secretly will destroy an atmosphere of trust. The only reasonable way is to measure the "as is" value candidly. One must stress to those involved that the idea of controlling is to *improve* performance rather than to entrap and punish those responsible for it.

Comparing "as is" with "to be" (the second step in Fig. 4-1) is normally referred to as reporting. Quite often, this is the core activity of a controlling department. The simplest form of report is a table with two columns containing the "as is" and "to be" values. Of course, more elaborate forms are usually created. Deviations are calculated in absolute or relative values, values are displayed graphically, and so forth. There are standard forms, and modern IT systems (ERP systems) create such reports automatically. However, the only justification for such reports is to perform the subsequent steps in Fig. 4-1 ("analyze difference" and "take actions"). These are normally done by the department manager. When asked about reporting, a department manager will typically show you about 10 different monthly reports. He or she rarely works with more than one of these, however. In some cases, none of them are considered useful. The existence of such useless reports can be attributed to the fact that the controlling department determines the content of the report. This is again a consequence of the linguistic mix-up. They create reports showing bad performance or good in order to judge rather than to improve performance. Reports should therefore be "ordered" by the departments that will use them. Individual departments need to state what must be in the report and how it should be displayed. The controlling department should deliver the requested service. (Sadly, I have never found a company that works in this way.)

The third step in Fig. 4-1, "analyze difference," is probably the core duty of every department head. He or she is the only one who can perform it, and it should be in his or her own interest to do so. In reality, this activity is rarely performed by the department head. It is either not done at all or it is carried out by the controlling department. In either such case, the controlling will be a futile exercise. In the first case, the reason is obvious. In the second case, this is true because the controlling department cannot possibly have expertise about each and every department's daily business.

The fourth and last step shown in Fig. 4-1 is in some sense the most important. Without it, nothing will change, and that nullifies the reason for controlling in the first place (which was to improve performance). Reality shows that the last step is rarely performed. The reasons for this are manifold. Laziness may be one of them, but I suggest that it is again due most often to the linguistic mix-up. When people feel checked up on by the controlling process, they will do everything they can to conceal problems. Taking corrective actions will involve many people. Sometimes it will be necessary to carry out a project. Everybody will be aware that something went wrong. So, camouflage is taken as a way out.

Every major company today undertakes controlling. All will probably agree that Fig. 4-1 shows the four basic steps, and everyone will claim that the four steps are performed in his or her company. The way to confirm this is to ask for examples and (written) evidence for each of the four steps. More often than not, such a query will demonstrate that not all of the four steps are performed. (While more than 90% of companies typically carry out the first step properly, fewer than 10% perform the last step.) But the four steps are like links in a chain. If one link breaks, the entire chain is useless even if the other links are super strong. So, if one of the steps in Fig. 4-1 is not performed properly, the entire controlling procedure might just as well be abandoned. In this situation, the other steps will be a waste of resources no matter how excellently they will be carried out.

4.2 Frequency of controlling

All steps in the controlling process in Fig. 4-1 should be conducted at the same frequency. (As a simple matter of fact, no step in Fig. 4-1 can be performed more often than is the step preceding it. It is possible to perform a previous step more often than the one following it, but this is of no use.) So, how often should controlling be done? There is no general answer. One may say as often as necessary. Too rarely is risky and too often is a waste of resources. The question of frequency needs to be given proper consideration.

It is easily seen that there is a maximum reasonable frequency, and that is based on the time interval at which measurements can be taken. Any higher frequency would be a waste. This is easily seen in an example. Sales figures (e.g., number of products sold or total revenue) are quite often an important controlling variable. For a bakery, the number of rolls sold is important. It is reasonable to control this figure daily, because hundreds of rolls may be sold every day and each day's rise or fall in sales might be due to a different reason. In contrast, a company selling nuclear power stations might sell one only every couple years. In this case, even an annual control of sales figures is useless.

In addition, the nature of human beings and the essential reason for controlling point to a certain minimum frequency. Bear in mind why controlling is carried out in the first place: it is to improve performance. To improve performance, one must make changes. Things must be done differently, and things are done by people. (Even when machines perform tasks, they perform them in ways managed by people.) Therefore, successful controlling tells people how to work better "tomorrow" by analyzing how they worked "yesterday." Now, taking "tomorrow" and "yesterday" literally, there should no problem in making an adjustment tomorrow based on data from yesterday that was analyzed today. However, there is a more obvious problem if this involves "yesteryear" and "next year." Human memory is not sufficient to analyze the mistakes of yesteryear. Therefore, annual controlling will not be effective. The potential threshold frequency depends on the individual. For somebody who is not very smart and does not have a very good memory, anything much longer than a day is far too long. But even very clever people with excellent powers of recollection will have their limits at around three months.

In summary, then, we have a necessary minimum frequency (f_{min}) and a reasonable maximum frequency (f_{max}). A suitable frequency in practice can be chosen so long as $f_{min} < f_{max}$. But fundamental problems will occur if $f_{min} > f_{max}$. Such situations will be discussed in subchapter 4.3.

4.3 Problems and shortcomings

This subchapter addresses problems which occur for principle reasons. It leads to the conclusion that controlling is not always possible. The main reason for this relates to differences in time scales, as discussed in the previous subchapter 4.2. In order to change the behavior of a human being, controlling must analyze the *recent* past. Over periods of, say, a year, nobody can remember the details as to why something went wrong. Nevertheless, some variables change only over such a long term. There are even variables that vary over an interval much longer than the human life span. The quality of wood produced in a forest is an example. The main point is that controlling such variables is completely useless. To ignore that reality not only will lead to a waste of resources, it also will give rise to arbitrary results. It is likely to be very damaging to make adjustments on the basis of such haphazard findings.

Sometimes it is possible to change the controlling variable in order to avoid the problem mentioned in the last paragraph. Typically, this is accomplished by taking an indirect measure. Revisiting the aforementioned example, the quality of a grown oak tree may show up after 250 years. In order to avoid this obvious problem one may take an indirect measure such as the annual growth rate (which is still a too-long period). There is, then, an assumption that the short-term indirect measure is truly indicative of a long-term result. This is by no means always clear, and especially if something new is being tried. What's more, people normally want that their controlling variables to look good. They will therefore be tempted to do everything in their power to ensure that the indirect measures do look good. This tinkering with the indirect measures is sometimes done in ways that completely disregard any connections with the corresponding direct measures.

Another situation where controlling is impossible has been discussed earlier in subchapter "3.2 An example of BSC." There the following two problems were stated:

- One does not find an activity really connected to the measure.
- Several activities significantly influence the same measure.

As discussed there, these difficulties might also lead to situations where no controlling is possible. Although such problems arise from the BSC approach rather than the controlling process, the effect on controlling is the same.

In the situations stated above, where controlling is impossible, there is only one piece of advice: Do not control! But what then should be done? Sometimes, simply nothing. There are situations where one has to wait for the outcome. Such situations should be *easy* for the management, because *no* management is necessary. A good manager recognizes such situation and relaxes. An inexperienced one might become nervous and agitated.

4.4 Examples

Now I will give a few examples. These are real cases. I start with a situation where controlling is possible, then I will discuss situations where it is impossible.

Case: Aluminum tube welding

Quite some time ago, I was heading a production department. The department was producing welded aluminum tubes. The top management demanded "better" performance. The production workers claimed that their performance was as good as it ever was, and that in fact it had been optimized over the years. There was no proper controlling to prove either side right or wrong. Of course, there were controlling *reports*, based upon the gathering, analysis and collation of a great deal of data. The first problem with these was that the monthly reports appeared in the middle of the following month. They provided measures for performance that were on average four weeks old. Such a time span is much too long for the controlling of production workers. The second problem was that the report contained very much data, and it was not at all clear which were relevant. "Tons per shift" had been selected as the most important measure, and the tons per shift were much lower than they had been some years earlier. There was an easy explanation for this: Over the years, the customers had been ordering thinner and lighter tubes. Producing a thin tube consumes almost the same time as does producing a thick one. (The typical rate per machine was around 100 meters per minute.) Furthermore, fewer people per shift were working today compared to previous years. There was evidence that this had slowed the process.

All in all, the production workers had good reason not to accept the performance measure “tons per shift.” Needless to say, such controlling reports had no effect on their performance. After long discussions with the middle management, a new controlling variable was accepted: meters per shift and worker. Having determined a proper controlling variable, the “to be” value then had to be agreed upon. The value was derived from the general goal that the company must survive. This led to target values for the production cost and then for the meters per shift and worker. In order to have effective controlling, the new controlling process was performed daily. It was done without the help of the controlling department. Towards the end of each shift, every machine foreman was asked how many meters he had produced. The numbers were added and divided by the number of people. The result was marked by an “X-mark” on a big brown piece of paper. The controlling process consumed less than five minutes up to this point. In addition, the foremen gathered around the brown paper for five minutes and discussed the result and made commitments how to avoid today’s mistakes tomorrow. The result was stupendous. Within a couple weeks, the performance measured in meters per shift and person had doubled. For some internal reason, we had to stop this controlling process for a week. Within three days the performance was back to the old level. (Fortunately it took only three days to increase it again.) Even in today’s high tech world, I would not change this approach to controlling. Using a piece of brown paper instead of a computer was and is superior in this situation. It is much easier to trust the marks on paper written there in the department than it is to believe in a report e-mailed from a controlling department. Furthermore, it made clear that this controlling was intended for the production workers and was not a checking up from the management. (One time, I was asked whether I would report the data to the top management. I said no. When the paper on the wall is full, I will discard it and get another piece of brown paper.)

Case: Management consulting

Management consultancies are hired by companies in order to increase performance. With very few exceptions the final goal of such projects is to increase the company's net income. The controlling variable of choice might appear obvious: net income. It can be easily measured monthly, and, by doing so, the performance of the management consultants also is easily measured. Although I personally never was, many consultancies are paid by their clients in proportion to the change in the agreed upon measure. This is a case in point as to where controlling is impossible. Although the controlling variable is easily and exactly measured, it is not connected to a single cause. Increasing or decreasing profits may be due to many reasons. It could be a consequence of world market developments, the actions of people not connected to the consultants, or the actions of the consultants. A breakdown into the different causes is impossible. It is a situation where the controlling variable is associated with many activities, and it is therefore unsuitable as a controlling variable.

The sometimes long time scales make the problem worse. Consider, for example, an assignment to implement a new controlling system. The only point of such new system is to increase net income eventually. However a positive effect may take years to show up. Nobody can determine whether a 20% increase in net income after three years has anything to do with the new controlling.

In summary, controlling of performance in consulting is impossible for fundamental reasons under most circumstances. It may be possible, therefore, that bad consultancies will survive while good ones will fail.

Such a sad fact certainly contributes to the sometimes poor image of consultancies.

Case: R&D Controlling

In research and development (R&D), controlling is also tricky and rarely possible. Perhaps the best example is of a research center for a big company or similarly large state-owned institution. The principle goal of such an institution is to apply science in order to obtain ideas for new products or fundamentally improved ones. If an idea is "good," it will eventually lead to additional revenue and profit. The general problem is again the difference in time scales between when something is measured and when the effect shows up. The research may start and end in year one. The profit will show up in year two or more likely in year three. In contrast to the previous case, the cause of the additional revenue can in most cases be traced to the particular invention. But the researcher will receive information about success or failure a year or two after he or she has finished the work. (In some cases even very many years after the research has been carried out.) Therefore, the feedback circuit will not work. But here the problem is even more fundamental. Not only is it the case that the researcher does not *know* whether his or her work has been successful at the time the work is finished, because success or failure will show up later, but the success or failure does not even *exist* at the end of the work. Therefore, not even a substitute controlling variable can be found. If something does not exist, it cannot be measured – not even indirectly.

This straight logic is mostly ignored. In an institution I have in mind indirect measures are defined. As in most other research institutions, the number of patents is taken as a measure. It cannot in fact be even an indirect measure. The pseudo-logic for choosing it goes as follows: Analyzing patents from the past may yield an actual average value per patent. Taking this value multiplied by the number of patents, so the thinking goes, should equal at least the total long-term profit initiated in this year. To accept such a forecast, however, one must assume that the average value per patent is fixed – which is decidedly not the case. When people are evaluated by the number of patents they obtain, they will try to apply for as many patents as possible. In doing so, more and more low-value patents will be created. At best, the real output will stay constant while the number of patents grows tremendously. Because applying for even a useless patent ties up research capacity, net output can easily shrink with the number of patents.

Some time ago, the head of a research institution showed me (and other people) his new controlling based upon number of patents. Because he is very smart man, I could easily relate to him the logic of the previous paragraph. He understood it immediately. However, he was adamant that he had to take *some* measure. I suggested taking the shoe sizes of the researchers. It, too, has nothing to do with the output, but at least it is very easy to measure. I am afraid the controlling system based on number of patents is still in use today.

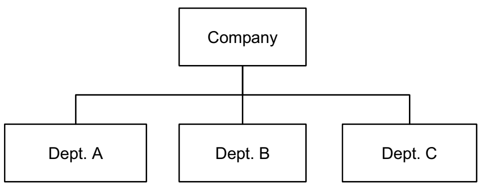
The main problem in this case is that success or failure does not exist when the work is finished. The important prerequisite of a suitable controlling variable that something relevant be measured can be illuminated by another but slightly different situation. Consider an institution where *basic* research is performed. Researchers try to find out about the origin of the universe or something similar. Obviously nobody seriously tries to create profit from such ideas. Such institutions sometimes take "number of articles published in a famous journal" as a controlling variable. Such controlling approach is much smarter than the number of patents discussed above. In this case the "number of articles published in a famous journal" *is* the result of the work. Success or failure materializes at the moment when the article is accepted for publication, which is normally at the end of some research period. Therefore it is a true and direct measure. The only slight problem here is that the work leading to such a publication may take six months to a year. That means a monthly controlling of the research work is impossible. Nevertheless, for a shorter time period, a number such as “cost per publication” can be measured and used as a good controlling variable for the institution as a whole.

5 Organization

It is considered part of a manager's daily business to change or to improve an organization. In that lots of projects deal with organization, and many companies have an organization department, it should come as no surprise that numerous books have the word organization in their titles. Business schools have standard classes on organization. One may conclude that organization is important and well understood. While I agree with the first statement, I object to the second one. In fact, there is not even agreement as to the meaning of the word organization.

In this chapter, I will deal with two aspects of organization stated in the questions below:

Fig. 5-1: *Organization chart*



Who is whose boss?

	Dept. A	Dept. B	Dept. C
task 1	X		
task 2		X	
task 3		X	
task 4			X
task 5	X		

Who does what?

Most managers will agree that the questions of Fig. 5-1 have to be answered when tackling the issue of how to organize. They must decide which department is an independent unit or subdepartment or whether it is reasonable that task 3 is performed by Department B rather than Department C. The importance of such decisions is obvious. However, no guideline exists for answering such questions.

Lots of effort has gone into classifying organizations. In particular, the form of organization on the left side of Fig. 5-1 has been classified thoroughly. One form has been named *functional organization*, for example. But neither naming nor creating advanced forms of displaying it will help in choosing the right organization.

The goal of this chapter is to show how to find an organization as indicated in Fig. 5-1 for a given business. In subchapter 5.1, I will explain a procedure to define roles and responsibilities. (The "Who does what?" of the right side of Fig. 5-1.) In 5.2, I will explain how to determine an organization (both sides of Fig. 5-1). I will also define the standard forms of organization. Once the organization is determined, one must then decide how many people are necessary in each department (subchapter 5.3). A new understanding of how many subordinates a boss should have will be discussed in subchapter 5.4. This is the so-called span of control. In 5.5, I will put Michael Hammer's reengineering into proper perspective. The buzzword "process organization" will be critically reviewed in 5.6, and the myth of self-organization will be untangled in 5.7.

5.1 Define roles and responsibilities

The question of who is doing what is seemingly simple. Quite often it is answered in the form of a table like on the right hand side of Fig. 5-1. Just write the things to do (tasks) in the first column and the people or departments doing it on the top row. By checking off the appropriate boxes, it would seem, the job is done. Just consider, however, the example below. Although Fig. 5-2 looks easy to create and understand, it bears some difficulties. First of all, one needs a list of tasks. To be more precise, it should be a *complete* list of tasks. Depending on the size of the company or department, the number of tasks easily runs into three digits. Simply brainstorming or listing typical tasks will not get the job done, as such a list will never be complete.

Fig. 5-2: *Table of activities*

Tasks	Board of directors	CEO	CFO	VP purchasing	VP production	VP sales
Calculate ROI for new machines			X		X	
Approve investment	X	X	X			
Set selling price					X	X

The only way to obtain a complete list is to perform a business process modulation (cf. chapter 2). All the tasks resulting from the modulation form the desired complete list. (Software tools for displaying processes normally have an export function for this purpose.) Note that modeling a business process may involve a huge amount of work, but there is no alternative.

Let us assume that the list of tasks in Fig. 5-2 was complete. Simply ticking off boxes is still far from logical. Consider the first task, "calculate ROI for new machines." The VP production probably carries out the task and the CFO helps him or her by providing some guidelines. Alternatively, the CFO might be in charge of this task and the VP production just supports him with information. Either way might be reasonable, but the Xs above do not distinguish between the two. This may also be the case with the other tasks. Another problem lies in the roles of high-ranking people or institutions, like the CEO or board of directors. Along with the CFO, they also have Xs for the task "approve investment." This emphasizes the importance of the decision, showing that they are involved. However, the involvement of the board of directors might differ a lot from that of the CEO or

CFO. In some senses, the CEO (and the board of directors) should have Xs for each of the tasks or for none.

In summary, an X in Fig. 5-2 means "being involved in some way." However, a person may be involved in many different ways. Describing this implies a need for many different forms of check marks. The four letters R, A, C and I can provide more information than does X. These stand for responsible, accountable, consulted, and informed, respectively. They are defined as follows:

Fig. 5-3: *Definition of RACI*

Responsible:	The person actually doing the job. There is at least one R for every task. There may be many Rs for a particular task (teamwork).
Accountable:	The person who takes full accountability. There must be exactly one A for every task.
Consulted:	A person who must be consulted before the final decision is met. He or she has a power of veto. (Do not use superfluous Cs.)
Informed:	A person who is merely informed about the outcome.

With such definitions, Fig. 5-2 can be made much more precise. Consider the following form:

Fig. 5-4: *RACI charter of activities*

Tasks	Board of directors	CEO	CFO	VP purchasing	VP production	VP sales
Calculate ROI for new machines			I		AR	
Approve investment	C	C	AR			
Set selling price					R	AR

Here the VP production actually calculates the ROI and is fully accountable for it. The CFO is just informed about it. The investment is approved by the CFO. The CEO and board of directors may use their powers of veto. However, they cannot approve an investment if the CFO disapproves it. They are also not allowed to change the investment sum. (Even the CFO cannot change the investment sum. Only the VP production is allowed to do it in the example of Fig. 5-4.) The sale price is set by the VP production and the VP sales. This is reasonable, because one knows the cost and the other the market prices. However, the VP sales is accountable. Probably he or she is also accountable for the profit finally made.

The primary application of the RACI method is in organizing a new business. Consider the real life example of subchapter 2.2. In Fig. 2-10, Fig. 2-11, and Fig. 2-1, the process for reaching make or buy decisions is displayed. When such a new process has been developed, a list of activities can be extracted easily. They are the 16 entries on the left hand side of Fig. 5-5.With just 16 activities, this real life example can be considered a simple one. The R, A, C or I determinations in Fig. 5-5 represent compromises reached after many discussions with the departments in the top row (from "Head of Techn. Operations" to "IOB"). When the table of activities is much longer, a hierarchical approach is useful. In Fig. 5-5, one would only consider as group activities "1 create ideas," "2 estimate potential," "3 decide," "4 plan project" and "5 run project." A small group of senior managers will discuss the distribution of R, A, C and I for these five activities. Then each manager has to discuss the subactivities (here 2.1 to 2.6 and 3.1 to 3.5) within his or her group separately. Rather long lists of activities are easily handled in this manner.

Another example of using the RACI method is to analyze an established organization. The question to answer in this case is whether there are shortcomings in the present organization. Again, one needs to know all the tasks for the process under consideration. One will have a list of tasks like that in the left column of Fig. 5-5. Then

Fig. 5-5: *RACI charter for make or buy process*

		Head Techn. Operations	Production cost controlling	Int. production coordination	Process heads production - incl. quality - national and internat.	EQM (or local equivallents)	Head CP	CP project management	Project lead	Purchasing base materials	Purchasing finished goods	Purchasing packaging	PM CP subsidiaries	CFO rtp (Market. & Sales)	IOB
1	create ideas	I	R	R	R	R	R	AR		R	R	R	R	R	I
2	estimate potential		R	R	R	R	R	AR			R*		R*		
2.1	examine legal situation					R		I			AR*		AR*		
2.2	search for internal production side			R				I			AR*		AR*		
2.3	draft production process				R			I			AR*		AR*		
2.4	document							AR							
2.5	determine feasibility		R		R	R		I			AR*		AR*		
2.6	consider change of supplier							I			AR*		AR*		
3	decide	C					AR								I
3.1	accept application form						AR								I
3.2	inform IOB						AR								I
3.3	evaluate comments	I					AR	R							
3.4	approve through techn. Operations	AR					I								
3.5	appoint project lead	I			I	I	AR	I	I			I		I	I
4	plan project				C	C	C	I	AR			C*		C*	
5	run project					R		I	A			R*		R*	

R: responsible, doing the job
A: accountable (exactly one A per line)
C: consulted (veto power)
I: informed
* depending on material one column will be filled only

one should independently interview as many people as possible. The general question is whether the resulting organization is reasonable as defined in subchapter 5.2, "Defining an organization." Oftentimes, quite striking shortcomings can in this way be rather easily found. Typically, one or more of the following problems will exist.

- Not everybody has the same view about how the company is organized.
- There are some tasks for which no one is accountable (no A).

- There are some tasks for which two or more people are accountable.
- There are too many people with power of veto (many Cs).
- There are too many Is.

If the view of the organization differs from person to person, then one might call it chaos rather than organization. Of course, the daily routine will suffer. Just handing out a sheet of paper detailing the one and only organization will not cure the problem under most circumstances. The reason for having different understandings of the organization is normally not lack of information. Rather, it is that different people would like to have a different organization. For example, somebody eager to be in charge will claim to have accountability (A) for almost every task. Many group meetings and one-to-one discussions are normally necessary to find the real reason for this and eventually to fix the problem. It is in fact a job for a psychologist rather than a business manager, but there is no alternative to it. (In my experience, managing a corporation is at least 50% psychology in any case.)

Lacking accountability (no A at all) is a typical problem for the public sector or for very large (centralized) companies. (The two are quite similar in most respects.) In such organizations, almost everybody thinks he or she is too far down the (huge) hierarchy to be accountable for anything. If one asks who is really accountable for something, the typical answer is “the CEO” or, in the case of governmental agencies, “the Minister.” It is obviously impossible for a single person to be accountable for very many tasks. He or she cannot make thousands of decisions each day. This would result in no decisions being taken at all or to a virtual standstill. That is why such corporations show tremendous inertia. It is a cultural problem rather than a technical one of lacking A. To create real change will take time. Rigorous decentralization might be the fastest cure.

Several As for a single task creates just the opposite problem from having no A. If two independent decisions are taken simultaneously, they will most likely differ. The result will be fighting rather than moving in a single direction. Two potential reasons lie behind the problem, and they need rather different treatments. First, it is possible that there are many young and eager junior managers. They tend to judge their ranks by the numbers of As they have. Usually, this problem is easily fixed. Such people see that it is impossible to have two As for one task. They will fight in order to be awarded the official A, but they will not tolerate a situation with double accountability. Second, a senior manager sometimes claims a second A for each accountability of his or her subordinates. This problem is much harder to fix. Sometimes, such a senior manager is not claiming accountability in the official RACI chart. Rather, he or she just lives that way. Such a manager normally has two basic but conflicting rules: i) I am not able to take all decisions in the department that I am accountable for, and ii) I cannot stand it if my subordinates make decisions over my head. The contradiction is obvious when written down in this way, and the only reasonable way out is to ignore basic law ii. This is easier said than done. The cited contradictory rules are never written down. They are present only in the subconscious. Such a senior manager needs to experience the problem personally in order to solve it. It will take time, and professional coaching might be necessary.

The problem of too many Cs is closely related to the problem of the previous paragraph. Veto power is the same as having some accountability. However, a strict differentiation between "accountable" and "consulted" should be made clear. There are two reasons why unnecessary Cs occur. One is a boss who is not willing to give full accountability to his or her subordinates. Due to such behavior, the organization becomes very slow. One must wait to act until every holder of a C agrees. Activity "4 plan project" in the real life example of Fig. 5-5 is a typical case. In such cases, one should recognize emphatically that it is a burden to have a C. Where a C exists, only a very short time should be allowed for executing the power of veto (e.g., 24 hours). The second reason for too many Cs is due to the subordinates rather than the boss. This may sound surprising at first, but some individuals shy away from taking accountability. They are afraid of making the wrong decision and prefer to have one or more senior managers to nod their heads in agreement. In effect, then, nobody is really accountable. In order to avoid such situations, there should be an explanation for every C. Why is it unavoidable? How is the situation really better because this additional C exists?

In many companies, travel expenses create the prototypical example of too many Cs. A person who is going on a business trip is of course accountable for the cost. He or she will normally fill out the expense sheet and sign it. In most cases, however, several additional signatures are necessary. This culture of control takes away full accountability from the individual person, and it should come as no surprise that costs rise when nobody is fully accountable. The individual who took the business trip might only be *trying* to get reimbursed. In his or her opinion, others (the ones with the Cs) should decide what is possible or not. There is a story of manager from the United States who decided that he would no longer sign subordinates' travel expense sheets, that they should themselves be responsible for their expense own reports. Surprisingly, his subordinates ignored that order. They still handed in their travel expense sheets to him. He eventually burned the sheets in public in order to emphasize what he had decided. After that, everybody signed the expense sheets on their own. The result was a significant decrease in total travel expenses. Now everybody tries to avoid unnecessary costs.

The last problem with the assignment of roles and responsibilities is that of superfluous Is. This does not hinder the process directly. It is no longer difficult to send out information to many people, especially if e-mail is used. The problem is in receiving that information. This sometimes implies a huge workload. I know managers who have spent a couple of days sorting their e-mails after a two-week vacation (just to decide whether the messages require action, storage or deletion). In addition to creating an unnecessarily huge workload, this often results in the loss of important information. In order to avoid this, one should allow the information flow only if the official RACI charter shows it. Furthermore, the necessity of each 'I' in the RACI charter should be justified in writing. Sometimes even that does not help. The reason behind sending out information to everybody is sometimes to show how much a person is working or how important he or she is. In that case, the problem is cultural rather than technical. A solution will take time. Perhaps an example will help to show how silly such a situation can be. Quite some time ago, our project team of management consultants happened to be located in the postal room of a big company. This was in an age before e-mail. In order to demonstrate what mail contained unnecessary information, we started to take away seemingly useless mails, such as meeting protocols for many cc recipients. We had gathered 50 kg of paper after two weeks. Surprisingly, nobody even noticed anything missing. A secret intracompany spam filter would probably yield similar results today.

5.2 Defining an organization

Defining an optimal organization is arguably the core task of a manager. For this reason, it should be the core competence of a manager. This subchapter, then, may be considered the most important one of this book. The justification for many of the previous chapters is mainly to understand this subchapter.

To choose an organization is essentially to draw an organization chart (cf. left side of Fig. 5-1). One may draw such a chart from scratch (a rare task), or one may optimize an existing one (an almost daily business). Most managers will consider it trivial. Quite often, "gut feeling" is used. There is nothing wrong with gut feeling. In general, I think that there is too little rather than too much gut feeling in modern management. However, some construction rules can be recommended. Note that the defining of an organization refers to the left side of

Fig. 5-1. However, the organizational chart has no meaning if the roles and responsibilities (cf. right side of Fig. 5-1) are not also defined. It is therefore indispensable to think about both roles and responsibilities and the organization chart simultaneously. They are mutually dependent.

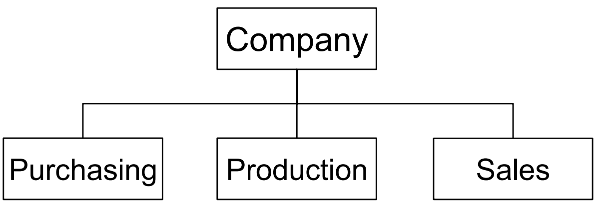
First, I discuss basic forms of organization (section 5.2.1). This part summarizes some general wisdom about organizational forms. Its content can be found in many books dealing with organization, but a short review is I think useful here. Advanced readers may prefer to skip this section. The next section (5.2.2) discusses the basic procedure. Its chosen title is deliberately technical ("To engineer an organization"). In section 5.2.3, I comment on personnel problems that quite often dominate organization.

5.2.1 Basic organizational forms

For big companies, an almost indefinite number of organizational charts may be drawn. They are, surprisingly, variations or combinations of just three basic forms. These basic forms are discussed below. In addition to definitions, the pros and cons are explained.

Fig. 5-6, Fig. 5-7 and Fig. 5-8 give three simple examples of an organization. In Fig. 5-6, the company is ordered by tasks. Here three typical tasks are chosen: "to purchase," "to produce" and "to sell."

Fig. 5-6: *Organization by tasks*



There are, of course, very many different tasks carried out in a company. Therefore, one could come up with many different examples in this category. This "functional organization," as it is sometimes called, is the classical form of organization. About 50 years ago, almost all companies were organized this way. Today, only smaller companies choose this form. This organization dates back to Taylor, who stated his principles of scientific management about 100 years ago. The general idea was to group together all tasks that are "similar." In doing so, experts for a single task will perform the task optimally. Idle time will be minimized, because each particular task is centralized inside the company. For this reason, it is possible to prove mathematically that this organization will lead to the least effort and, therefore, to the lowest cost. From this, it appears to be the only reasonable organization. Such a conclusion is shortsighted, however. In addition to the operational tasks indicated in Fig. 5-6, the firm also needs management. In particular, somebody must tell purchasing what parts to buy. The same is true for production. Somebody has to say what should be produced and when. This additional effort must be added. It is easy to see that this management effort grows exponentially with the size of the company. Therefore, it is clear that such functional and centralized organization is optimal only for companies up to a certain size. But other drawbacks appear long before this limit is reached. First, the management can be quite complex. As complexity increases, so does the error rate. Such mistakes will lead to extra effort and cost. In the example of Fig. 5-6, one may end up buying too much or too little or producing too early or too late. Second, organization by tasks does not foster motivation. People see only their limited regimes. They are working according to order, and normally they do not know the reason behind the order. Especially with today's highly educated people, this management approach is not appropriate. One hundred years ago, when Taylor lived, the situation was very different. In his time, it was correct to state that a laborer should work and should not waste time by thinking.

Both the complexity of management and the lack of motivation made people think about other organizational forms. Organization by products or markets, as displayed in Fig. 5-7 and Fig. 5-8, respectively, are alternatives to organization by function. Organization by products stresses the technical aspect. In this model, all activities necessary to create a certain product or, more often, product group are put

Fig. 5-7: *Organization by products*

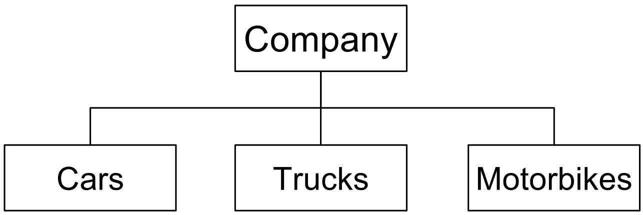
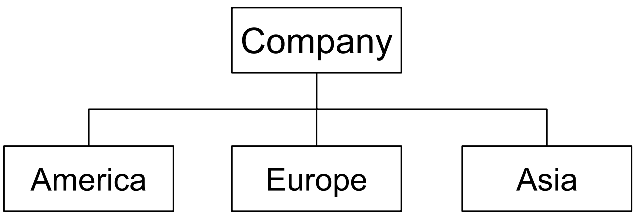


Fig. 5-8: *Organization by markets*



together. Therefore, each of the three departments of Fig. 5-7 might have its own purchasing, production and sales. The idea behind the market organization of Fig. 5-8 is quite similar. In this model, the customer stands in the focus. Activities necessary to serve a certain market are put together. For example, in Fig. 5-8 all three departments might have their own sales departments. The pros and cons of product or market organization are identical. Both need less management than the functional organization. They are decentralized and therefore less complex. In both organizations, each department contains the variety of tasks found in an entire company. In each department, it is easy to see why certain things must be done. Motivation is therefore high. In some sense, all departments may be considered independent subsidiary companies. This approach is the main idea behind a profit center organization, which is easily possible in this case. (This is almost impossible within a functional organization.) Managing a department by just one number (profit) is very simple. On the negative side, the organizations of Fig. 5-7 and Fig. 5-8 create perhaps unnecessary multiplication of activities. One needs three personnel departments, three controlling departments, three purchasing departments, and so forth. Especially in smaller companies, such duplication of activities is unbearable. Therefore, one will scarcely find a pure product or market organization in a small company. There is yet another problem in these organizations and, although it is rarely mentioned, in my opinion it is the most crucial one. Each department (be it a profit center or not) needs an entrepreneur as a leader, and good entrepreneurs are hard to find. Especially big companies often create excellent administrators rather than independently thinking entrepreneurs. They may even be afraid of them. (As Thomas Jefferson once said, "Timid men prefer the calm of despotism to the boisterous sea of liberty.") Even if suitable entrepreneurs are found, some companies have severe problems with fitting them into their payroll structures. Like a CEO or general manager, a head of a profit center will (rightly) demand to be paid in accordance with the profit he or she will have created. This will give rise to a situation where department heads of equal rank will have severe differences in income – perhaps even by a factor of 10. An excellent profit center leader may receive a salary higher than his or her boss deems justified. While this creates no problems in principle, it nevertheless will contradict most payroll scales eagerly developed by senior personnel managers.

In reality, big companies will normally use more than just one organizational principle. Functional organization is chosen especially for the lower levels of a product or market organization. This is easily explained. I argued that functional organization is not good for big companies because they are too complex to manage. A product or market organization is not good for small companies because too many resources would be wasted. Therefore, one may prefer a market or product organization for the top level where the company is still "big." At lower levels, one has in essence a small company that justifies a functional organization.

Besides having different organizational principles at different levels, one may mix two or more principles on the same level. In Fig. 5-7, one may have three independent product departments but one may add a centralized sales department. Or the sales activities are ordered by regions leading to a mixture of product and market organization. A special form of mixture is the so-called "matrix" organization. In this case, there will be two organizational principles and two "accountabilities." For example, one may again consider the product organization of Fig. 5-7 complemented by a central sales department. If the remaining departments ("cars," "trucks" or "motorbikes") also have sales departments, then one may speak of a matrix. Such double accountability in sales is forbidden by the RACI rules of subchapter 5.1. In such organization, one must set strict guidelines in order to avoid chaos. Even with the best guidelines, though, many arguments will start. Suppose there is a head of Asia and a head of trucks. If sales of trucks go down in Asia, the head of sales will probably blame poor quality, while the head of trucks will blame lousy sales activities. Though a matrix organization combines the positive aspects of two principles, it demands a rigorous top management to deal with the likely arguments. One retired CEO of a multinational company had a very useful and successful approach in his very well working matrix organization. He gave the following order. If two department heads have an argument, they should first try to come to a mutual agreement. If they cannot find one, they should come to him. However, he would only give them one chance. If they came back to him a second time, both were fired. To my knowledge, nobody came a second time.

The matrix organization combines two organizational principles simultaneously. In principle, more than two are possible. One may think of a technology company as having a matrix organization of geographical regions and products in order to emphasize its focus on customers *and* products. Management might also recognize that purchasing, logistics or personnel are very important. As a consequence, it might establish a central purchasing, logistics or personnel department in addition to those already existing in the regional and product departments. Such form is commonly called "tensor organization." It is even rarer than the ordinary matrix organization. While "matrix organization" is a reasonable term, the name "tensor organization" is in fact rather misleading. From the mathematical field of linear algebra, a matrix – or better an (m, n) matrix – is a scheme with m rows and n columns containing m times n arbitrary objects (numbers, colors, people, etc.). That suits well a matrix organization of, say, m geographical regions and n product departments. The so-called tensor organization, then, should be better termed an "(m, n, o) matrix" organization. In mathematics, a tensor is a very special form of matrix that is even more complex than is the organizational form sometimes bearing that name. Its elements must transform in a specific way when the space system is transformed. Like numbers tensors can be add and multiplied. They form a tensor space. Therefore it is complete nonsense to have a tensor containing departments, while a matrix of departments is as reasonable as a matrix of numbers.

To close this section I will define two other words used quite often when talking about organization: "centralize" and "decentralize." Functional organization is a centralized organization. A particular task is performed at one central department of the company. In contrast, product and market organization are decentralized organizations. A task like purchasing may be performed in many different departments. One may, using this definition, summarize this section as follows. A central organization avoids redundancy. However, its complexity grows rapidly and consumes lots of management power. In a decentralized organization double work may also develop, but complexity stays low and management workload is minimized. Although the optimal degree of centralization or decentralization is a function of size, it is difficult to calculate an optimum.[3] Therefore, centralization versus decentralization is quite often a question of taste and fashion. I personally favor a decentralized company, and I would note that managers are unduly biased towards centralized organizations. In centralized organizations, one has fewer shop floor workers and more managers. It is the opposite in decentralized companies. Because most organizations are created by managers, one may assume that, on average, an organization is too centralized. (In an old story, a retiring CEO gives three envelopes to his successor. He says, "If the company is not running well in the future open the first envelop and you will find good advice. When the company is running badly a second time open the second envelope, and so forth." At a time when the company was running badly, the new CEO opened the first envelope. He read: "DECENTRALIZE!" Some years later, he had occasion to open the second envelope and found the following message: "CENTRALIZE!" A few years later, he had to open the last envelope. In it was written, "Retire and write three new envelopes for your successor!")

5.2.2 To engineer an organization

In the previous section, I have discussed different forms of organization. This was nothing more than a definition of words. In this section, I will explain how to decide on the most suitable organization for a specific company. I note from the outset that there is no "optimal" organization and there is no rigorous standard procedure for optimizing an organization. Depending on a particular company's environment, one form of organization may be superior to another.

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[3] Management workload increases with size while double work decreases with the square root of it. However exact values are rarely known.

Therefore, it does not make sense to perform scientific research in order to find the best organization. It is like tailoring a smartly fitting suit. A suit must look good on a particular person. A tailor must know what to measure, what materials go well together, and how to cut and sew the fabric. With this knowledge, he or she will produce a decently fitting suit. To create the ideally fitting suit, however, the tailor must know the personal taste, style and bearing of the person to wear it. The same logic applies for finding a style of organization. There are certain rules and guidelines, which I will explain here.

When people speak of determining a new organization, there are two different tasks:

- To decide upon the organization for the top level (of a big company).
- To work out the detailed organization for the departments.

The two jobs require very different skills. I will, therefore, discuss them separately. The first (organization for the top level) sounds very dramatic, although it is in some senses easy. It is definitely a job that needs to be done only rarely. Top-level organization mirrors the company's strategy. In a company like Coca-Cola, the product is simple. The main skill is in selling the product (in slight variations) into very different markets. Therefore, one has to concentrate on the market. It comes as no surprise, then, that such companies have a market organization ordered by geographical regions. Technology companies, by contrast, may have complicated products. They will excel by developing and producing advanced products. Therefore, a product organization might be the first choice. Of course, even for technology organizations the customer is very important. Such companies sometimes choose a mix of product and market organization or sometimes the corresponding matrix organization. (Companies rarely use the term "matrix" in reference to their own organizations. A matrix is considered difficult to manage and to possess the aforementioned problems in accountability. It is out of fashion.) If we refer to the standard growth strategies from Ansoff's product/market matrix[4], choosing a top-level organization may be summarized as follows: A company with a market development strategy should choose a market organization while a company having a product development strategy should focus on a product organization.

The second job, to work out detailed organizations, is more tedious. Every organization bundles tasks in its departments. (This is also true for the top-level organization. Within a market organization, for example, there may be a department called "Europe." It is responsible for all tasks necessary to serve the European market.) The essential question is which tasks to put into a particular bundle. A very common but fatal mistake is to take a "top-down" approach. I will illustrate this way by the following example: A company decides to add a department called "Germany" to its market organization since it sees an important and promising market. The newly appointed manager for Germany demands managers for purchasing, production, sales, logistics, controlling, finance and personnel. The seven newly appointed managers will demand corresponding group leaders, and so forth. In doing so, a "nice" organizational chart will develop. However, it is by no means clear whether all the different departments and subdepartments are really necessary. Quite often, departments formed in this way have no clear idea what to do, and the manager in charge will not tell anyone about this predicament, as it might put his or her position at risk. He or she will think about and "find" some work. After one year, such a department is typically doing so many things that it needs to hire more people. To summarize, the top-down approach may create useless albeit very busy departments. As mentioned above, the top-down approach is the most common one. This (incorrect) approach is fostered by organizational rules often

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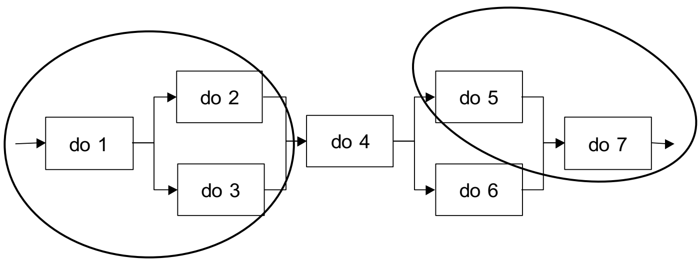
[4] Ansoff stated that there are four strategies to grow: i) with the existing product in the existing market (market penetration), ii) by developing new products (product development), iii) by finding new markets (market development), and iv) by selling new products in new markets simultaneously (diversification)

found in big companies or public administrations. Typical examples are rules such as, "A vice president may have five to eight department managers" or "A university department consists of at least seven professors." These are the principal reasons for superfluous administrations commonly found in government departments and some big companies.

So much for the wrong way. In order to avoid unnecessary departments, one should start with those things needing to be done at the lowest level. These are nothing but the business processes in detail. It is obvious that one must understand the activities before one can bundle them. Again, it becomes clear that one has to know business process modeling (cf. chapter 2) in order to create an organization. (None of the books on organization I know touch business process modeling!) The technique to form an organization is simple but tedious. Consider the process in Fig. 5-9. For simplicity's sake, it consists of only seven activities. Bundling means to put together activities that should be performed by one group or department, as

Fig. 5-9: *Bundling of activities*



indicated by the circles in Fig. 5-9. These bundles are the tasks to be performed by the organizational units on the lowest level. In a real situation, one may end up with 100 bundles. Obviously, 100 groups cannot report to one manager. Therefore, one must build bundles of bundles and these units have to report to a middle manager. If necessary, one should create bundles of "bundles of bundles," and so on. The question of how many units should report to one (middle) manager will be discussed in detail in 5.4, "Find an optimal span of control." For the moment, one may have in mind something between five and 10. The procedure appears to be straightforward and no superfluous units are created in doing so. There is only one important question: "Which activities belong in one bundle and which in another?" More specifically, "Which activities of Fig. 5-9 should be in a given circle?" There are some relatively well-known rules:

- Combine tasks of the same core competency.
- Combine tasks that use the same tools.
- Build bundles of equal workload.
- Minimize interfaces.
- Combine tasks using the same controlling variable.

I will comment on the five rules in the following five paragraphs. Of the five rules, one is extremely useful, some are occasionally useful, and one is complete nonsense. The first rule (bundle core competencies) is only sometimes applicable. If taken as the only rule within the entire company, one will end up with units performing tasks of very different areas of the business process. The management would be extremely complex. (It would, in fact, be an extreme and strange form of a centralized organization. As an example take a big production department where drilling and welding are two core competencies. If really all drilling and welding is done in one unit a typical product will be exchanged between these two units very often.) However, such a rule is suitable for very difficult tasks. Central R&D activities provide a good example. Here, experts are often hard to find and certain tasks demand highly specialized scientists. Note that such "difficult" tasks are not so common in today's companies. Less than 10% of all tasks are probably in this category.

The combination of tasks using the same tools is typical for production. One will use an expensive tool or machine as centrally as possible, for example, in order to avoid additional fixed costs. Not very many tasks fall into this category and the tendency is even shrinking. Consider a computer. In the 1970s and part of the 1980s, a computer was an expensive tool and therefore all IT activities were bundled into one (central) IT department. Today a PC is cheap and it can perform most necessary calculations. Consequently, central data processing is rarely seen today. Even where big and expensive computers are still necessary, networks allow different users scattered around the globe to use them.

The third point above states that bundles should combine equal workload. That is a general necessity, but it scarcely should be considered a rule for construction. It does not tell what to do, but it does emphasize what must be avoided: very small or very big units. Details about how many people should belong to one unit is a question of span of control (cf. subchapter 5.4).

To minimize interfaces is, arguably, the rule cited most often. And without any doubt it is utterly useless. This conundrum justifies this entire section. Although the rule sounds rigorous, it is rarely stated clearly. Interface refers to potential interfaces between organizational units. In Fig. 5-9, each circle has one incoming line and one outgoing line. Therefore, they have two interfaces with other organizational units. These interfaces allow some products or some information to go from one unit to another. Handing over products or information will require a certain workload that eventually translates into costs. Because minimizing cost is an important – and maybe the most important – guideline, one might conclude that it is important to minimize the number of interfaces. Assuming this conclusion to be correct, organization (or better bundling) becomes a clear-cut mathematical procedure once the process has been modeled. The task is to draw circles containing a certain workload (previous rule) and to cut through as few lines as possible. Solving such a problem involves graph theory. It is always possible to find at least a numerical solution. However, two errors lurk in the argumentation above. First, it is only possible to minimize the crossing of lines when a certain process network is given. From chapter 2, it is clear that there are many diverse and correct ways to model a process. Mathematically speaking, the same business process may show very different topographies that lead to different solutions. Second, it was argued that minimizing interfaces will lead to minimum cost. It is true that each interface implies effort and with it costs. However, different interfaces imply different amounts of cost. Therefore, it could be cost effective to allow three new (low-cost) interfaces in order to avoid one high-cost interface. Thus, the minimum number of interfaces does not ensure minimum cost. Although minimizing the number of interfaces is plainly an incorrect approach, it is by no means bad to think about interfaces. Consider the example of cost calculation for a new building. There may be two ways to bundle the activities in the cost calculation process. One way would be to group the activities necessary to estimate the costs of technical units, such as concrete structure, plumbing and painting. Another way is to divide it by first floor, second floor and third floor. The latter way is much more complicated. The different floors are highly interconnected. Organizing cost calculation by floor will require huge amounts of harmonization. One may say that the interfaces between the costs of each floor are huge. But note that the number of interfaces in each approach could be identical. In the second approach, the interfaces are "complicated." So, one may conclude that "easy" interfaces should be favored. However, words like "complicated" and "easy" are almost impossible to define quantitatively here. Therefore, while one should think about interfaces in constructing a new organization, doing so will not lead us to a suitable rule for determining an organization.

The last rule (combine same controlling variables) is the most important but least honored. The procedure runs as follows. First, one has to model the business process in sufficient detail. Then, one must think about the controlling variables as indicated in chapter 3. Each activity in the process has a controlling variable (e.g., cost or punctuality). If SADT (cf. section 2.2.1) is used, one may indicate these variables easily (arrow towards the top). Each controlling variable must be in *exactly* one bundle. In other words, the same controlling variable must not show up in different bundles. If it that were to happen, then two different organizational units would be controlled by the same measure. If something failed, neither would feel accountable. This rule, therefore, is an absolute necessity. If one tries to honor it, normally no further choices are possible. In many cases, it will be difficult to obey this rule. One may end up in concluding that the controlling variable has to be changed because one cannot find a suitable organization.

In the last five paragraphs, I have described how to construct an organization. The procedure is not complicated but it may be tedious. Note that constructing an organization from scratch is a rare task. Usually, one has to change an existing organization because the environment has changed (e.g., after a merger) or because the existing organization is ineffective. Typical decisions are whether to put two units together or whether to split a big unit. For such decisions, the above rules (especially the last one about controlling) are indispensable guidelines. To close this section, I will present two short cases where the rules are discussed.

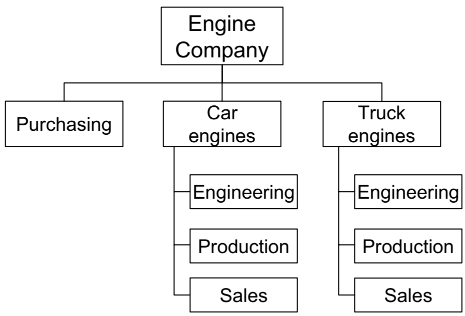
Case: University controlling

This is not a case from an ordinary business situation, but it well illustrates the connection between controlling and organization. A university professor delivers essentially two "goods." One is research (cf. cases starting on page 56) and the other is teaching, where the product might better be described as "taught students." I will focus here on teaching, a good over whose production there ought to be proper quality control. The starting point is to define a controlling variable. To name a controlling variable for this case is a typical exercise in one of my classes. Students typically cite things they remember from the professor evaluation of the previous semester or they connect their grades with the quality of my teaching. It is very easy to see that such variables are highly indirect measures of quality. Grades are wholly irrelevant, because they are determined by the professor. The categories of the professor evaluation seem like a better choice, but they, too, are far from reasonable. This is because the students might think they learned something useful, but whether or not it was in fact useful will not be known until much later. The usefulness of what was learned will not materialize until some time after finishing university. Measuring the usefulness at that (future) time is not so difficult. For a scientist, it may be something like whether he or she reached a faculty position. For a business major, it will be most likely his or her income. In any case, we have the regrettable situation where the frequency of quality controlling is too low to be useful for changing the daily behavior of a professor (cf. subchapter 4.2). Long-term judgment about the quality of teaching is possible, though. At this point, the question of organization comes into play. We have a product (educated student) and the measure of quality (his or her annual income). However, the activities involved in creating this product are manifold: lectures on mathematics, lectures on economics, lectures on accounting, etc. All these activities bear the controlling variable "annual income." But, in contrast to the fifth rule above (same controlling variable), these activities are not bundled together. The organization should be decentralized into something where a particular professor gets, say, 20 students and he or she is accountable (but not necessarily responsible) for their entire education. A good teacher will create successful professionals and that is easy to measure. (I have some further remarks to close this case. Such decentralized organization is by no means so strange as it appears at first glance. Many years ago, European universities were essentially organized in this way. Probably because people thought it would save costs, they started to centralize. For example, instead of having several professors just for, say, mathematics, they appointed one for algebra, one for number theory, and so forth. Of course, today's universities are big and have many students. Therefore, a decentralized organization would lead to less management effort and lower total workload, as has been already discussed in section 5.2.1. A centralized organization leads to a huge workload for administration and management in a big entity. This phenomenon is easily observed in today's universities. That there is a necessity for such centralization cannot be justified by the fact that the stuff of teaching has become more and more specialized. Such an assertion can be easily shown false by comparing bachelor-level education ("general" stuff) to PhD-level education ("specialized" stuff). Undergraduates are educated centrally while PhD students depend essentially on one professor.)

Case: Purchasing

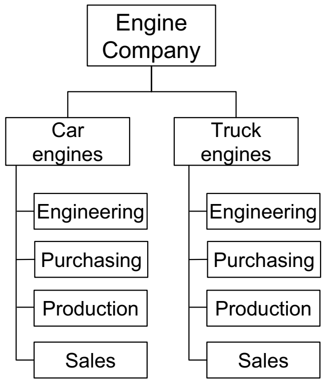
Consider a company producing engines for trucks and passenger cars. Fig. 5-10 shows a typical organizational chart. Car and truck engines have different customers and, due to their different sizes, differ in engineering and production. It thus seems smart to use product

Fig. 5-10: *Central purchasing*



organization. Because the raw materials for car and truck engines are partly identical or at least similar, and especially as the vendors are identical, a central purchasing department has been created. The activities in buying raw materials are identical for both groups. Furthermore, one might have a greater negotiating power due to the higher volumes in centralized purchasing. Alternatively, one might decentralize purchasing, leading to an organization as indicated in Fig. 5-11. Which organization should be preferred? The reality is that the centralized organization of Fig. 5-10 is found much more often than

Fig. 5-11: *Decentralized purchasing*



the decentralized one of Fig. 5-11. However, that does not answer the question. The majority may be wrong. Going back to our rules for bundling will prove the minority right. The departments "car engines" and "truck engines" have a clear main controlling variable: profit created from car engines and profit from truck engines, respectively. Profit is nothing more than revenue minus cost, and cost is crucially determined by the expense for raw material. Therefore, the heads of "truck engines" and "car engines" must be accountable for material costs. The activities of purchasing belong in their respective bundles. What's more, central purchasing has no reasonable controlling variable. It is just spending other people's money. This is a fundamental problem of any stand-alone purchasing department. Particularly horrendous examples of this may be found in public administration. Huge sections of government agencies are buying something eventually to be used by the citizens. Because buyer and user are far apart, however, it is impossible for the buyer to decide whether something is worth its price. As a consequence, the buyer will buy what he or she thinks is reasonable. People will complain if something essential is not bought, but they probably will not see the things that were purchased unnecessarily. This results in a situation where too much is bought at prices that are too high.

It is interesting to ask why people choose central organization in the first place and why others are still hanging on to it. Historically, central organization is easy to explain. A purchasing department needs certain tools to do its job. Fifty years ago, purchasing amounted to a big file cabinet containing all the data from vendors and orders. Such a data source simplified work by having telephone numbers and addresses of vendors ready. Furthermore, it could be used to exercise market power by knowing what had been bought already at a particular vendor. Decentralized purchasing would have necessitated double file cabinets with identical information. This would have been next to impossible. (It was a complicated and expensive tool and all activities using the tool were bundled together.) The situation in today's IT-driven world is completely different. The aforementioned file cabinet is now part of a sophisticated ERP system. Its data can be shared by many people, even if they are scattered around the world.

History aside, then, why are there still so many central purchasing departments? The simple answer is: "Because nobody changed it." The main point is that some people working in the central department will be hurt if the work is decentralized. Many myths have been perpetuated in order to keep such central departments alive. One is that the purchasing data (especially prices) must be kept confidential. A competitor must not find out this information, and, when several departments have access to such data, the information might easily leak to the outside. I do not personally believe that purchasing data need to be classified in the first place. (People like to classify their knowledge because it makes them feel more important.) Moreover, I am not convinced that wider access will necessarily lead to more leakage. The individual engineer constructing the engine knows the purchasing prices of the raw material, in any case, as otherwise he or she could not perform the needed cost calculations. Another legend is that technical departments are dominated by engineers rather than business majors, that engineers always want “nice” parts regardless of the cost, and, in any event, that they are unable to think economically. This is almost ludicrous. The engineers of technical departments determine most of the cost by their engineering. Furthermore, as profit center leaders, they are accountable for their costs.

I have set off battles in many companies about decentralizing purchasing. Sadly, in most cases the head of central purchasing won. In one of the few cases where purchasing was decentralized, it was due to a story told by the CEO. After listening to arguments from both sides, he remarked, “When I entered the business world some 30 years ago, I started my career in sales. It was very much in my interest to sell as much as possible for prices as high as possible. I was quite successful. One key to success was finding out that central purchasing departments were the easiest targets. They had no clue about the products and they accepted almost anything. They had no profit and loss responsibility. For exactly that reason, I want decentralized purchasing in our company.”

5.2.3 Personal conflicts

In the previous section I discussed how to construct an organization. Though this is the result of logical thinking, it is rarely found in any other book. Even more striking, it is rarely applied in the real world. So how do most people construct organizations? This section answers that question.

Up to this point, I have deliberately avoided one key point about organization: Organization determines who is whose boss. It thus defines power. Therefore, almost everybody in a company has a personal interest in a certain organizational form. This self-interest is absolutely understandable. (It can even be used to motivate. If a meeting organizer is worried that too few people will show up, he or she should add one last point to the agenda: "Organizational consequences of the points above." This will guarantee a crowded room.) Because self-interest is by definition not homogenous, constructing an organization in a team is difficult. There are two common ways to deal with this:

- The boss defines the organization.
- The order "no self-interest, please" is given.

The first approach is wrong in two ways. First, it does not avoid self-interest but guarantees that the boss's self-interest will dominate. Second, no single person will have sufficient knowledge of the business process to find an apt organization. I have observed this first way in reality. It transformed the company from one state of chaos to another. In addition, people began chatting about and blaming the boss for nepotism and the like. The second suggestion ("no self-interest, please") is plainly ludicrous. Just imagine 10 people in a room discussing organizational changes when five of them will lose their jobs. In that group, I would become furious if anyone told me "no self-interest please."

The only reasonable way to deal with self-interest is to take it seriously. One should try to avoid personal conflicts when staffing an organizational team. But if they are unavoidable, they should be made a point in the open agenda. Otherwise, hidden agendas and arguments will take over.

In reality, the problem of self-interest is mostly ignored. The following fears will dominate:

- Is my own job still safe?
- Will I advance in power or will I lose power?
- Who will be my future boss?

- Will my market value increase or decrease?

Such (hidden) fears have a major influence on building an organization. Many people try to find the ideal structure first and then look for a justification later. This is quite often done subconsciously. Another mistake is to build an organization in accordance with people rather than processes. Companies are rarely willing to lay off senior management. (It is much easier to sack simple laborers. The management does not face them personally.) Structures, therefore, are often designed from top to bottom. If six senior managers are available, then one constructs six departments for them. In order to justify this, faulty tools are sometimes used. A few of them have been described already (cf. subchapter 2.1). If nothing helps to justify it, it may be a good idea to call consultants. They can explain everything. Because they are very smart, they must be right. (Admittedly, I was one such “justifier consultant.”)

All of the above explains why organizations are rarely constructed properly. It also sheds critical light on “organization scientists.” I mean people who group organizational forms. They are essentially creating taxonomy. Empirical studies result in claims like, “80% of all companies in such and such industry have chosen such and such an organization recently.” These claims are most likely correct, but are not at all useful.

If self-interest dominates the way an organization is built, then inept organization is not the only problem. A bigger problem is the destruction of trust. Many people will recognize that the self-interest of a few people dominates the new organization. People talking openly about it will be sacked. The management will try to “explain” the inexplicable. In other words, they have to lie, and no one trusts lying people. Some managers think that their subordinates will not find out. Maybe they are good enough actors. However, a hidden lie is much more devastating than an open one. There is a chance that the lie may be pardoned in the latter case, but a hidden lie cannot be pardoned. More often than not, people *feel* the hidden lie. Trust is destroyed and no one knows why.

5.3 How to staff an organization

Once the organizational chart is properly drawn (subchapter 5.2) and roles and responsibilities are well defined (subchapter 5.1), the organization may start to work. The management in particular will not only be interested in who is doing what. It is of great interest to know how many people are doing something. (Number of people is directly related to cost.) Before going into this, though, I must comment on a misconception, which is that: Changing an organization changes the head count. In fact, if total workload is cut into pieces in different ways, the total workload stays constant. To achieve net cost savings demands other procedures (e.g., reengineering, cf. subchapter 5.5). Implementing the results from such procedures will sometimes require a changed organization. Cause and effect should not be mixed up here.

The question of how many people are working in one unit is not of interest only to management. It is also important for the people involved. The answer determines the number of jobs. Because this is a sensitive issue, consultants are often hired to bring in a "neutral" opinion. The reader may judge for himself or herself whether this opinion is truly neutral. Mistakes begin when too much is expected from consultants. They have no secret formulas to calculate the head count. There are three ways to find an answer and none is flawless. In 5.3.1, I will comment on a basic calculation of workload. Section 5.3.2 deals with comparing one unit to another (benchmarking), and in 5.3.3 a new approach using a feedback circuit will be introduced.

5.3.1 The bottom up approach

In this approach, the underlying process is considered in great detail. The degree of detail must be so great that even simple individual tasks are displayed. Consider the following example. A certain part of the tax collecting authority (e.g., the IRS in the US) might be in charge of just three tasks: checking the filled-out tax forms of individual citizens, entering the data into the IT system, and answering inquiries. The tasks may, on average, require 12 minutes, 8 minutes, and 7 minutes, respectively. Being responsible for 10,000 tax forms annually with 1,000 inquiries, one will end up with a workload of about 431 days (assuming an 8-hour working day). If there are, say, 220 net working days per person, then the work for 1 year one will required 1.96 people. So, two employees may be enough for the job.

A similar approach is quite often used by engineers in production. Although the approach is by no means wrong, the margin of error is quite high. Since the time estimates are only estimates, a typical margin of error is already implied. Furthermore, there are activities that do not normally show up in the process but that do consume time (going to the restroom is one of these). Another problem is that workloads are not linear. Checking 10 forms may consume 120 minutes, but checking 40 within eight hours is probably impossible. Without a proper break, the error rate will increase dramatically. Furthermore, a telephone interruption during one check will easily increase the necessary time by 50%.

To summarize, this approach may show a large margin of error. Yet, it is the only way to estimate a head count for planning a new process that does not yet exist in reality. (In some areas of production, the approach has been elaborated. Sophisticated tools such as REFA [a German procedure] lead, under certain conditions, to reasonable accuracy.)

5.3.2 The benchmark approach

In this approach, one unit is compared with another (cf. also subchapter 7.2). So, if one wants to know how many people should work in the personnel department, one may compare it with other personnel departments. One typically finds that the personnel department is staffed with 1% of the total workforce. So, if the entire company has 5,000 employees, then a personnel department of 50 people is justified.

The method sounds very simple, and it avoids the errors of the bottom-up approach. However, other weaknesses are present. Though two organizational units are identically named, they might perform different tasks, especially if the details are considered. For example, one personnel department may also manage the cafeteria while another is responsible for security. Another weakness is that one does not know whether the benchmark partner works efficiently. One will never achieve something that no one has reached before.

5.3.3 The feedback circuit approach

This approach surely delivers the best results. However, in Europe it is still in its infancy. It is partly used in the US. In this approach, one appoints a leader of an organizational unit. The tasks of the department should be well defined. Then a budget is set. It should depend on the "value" of the service that the unit delivers. The users of the service have to define it. (They also have to pay for the service eventually.) The newly appointed leader of the organizational unit is free to hire as many people as he or she wants. The salaries (including the leader's own) must be paid from the budget. The leader is even free to set the salaries of his subordinates freely. He or she may hire a few expensive, high quality workers or many less skilled but cheap laborers. Only two targets must be met. First, the demanded service must be provided. Second, he or she must stay within the budget. (There may be a bonus for staying under the budget.)

For a sales department, the approach is especially simple. Its head may be judged by "profit" only, where profit means essentially selling prices minus production cost minus cost of sales. The head of sales may set the selling prices and hire as many sales people as he or she wants. At the end of the day, profit must be maximized.

This approach has a certain charm. Lengthy and nasty discussions about how many people should work where will vanish without a trace. The less simple prerequisite is an appropriate culture. Some people might consider this approach far too capitalistic. Furthermore, it gives significant power even to low-ranking leaders. It might be too much to demand from them. Simultaneously, significant power is removed from the higher-ranking leaders.

The described feedback circuit approach is not limited to head count. It can also be quite successful in other areas where lengthy arguments are commonly found. A typical example is the question of who gets which office. This is also a question of hierarchy. Having a nice office shows power and prestige, and, of course, working in a separate office is nicer than sharing one. So, a smart company should calculate its gross cost of office space (say 30 € per month and m^2). It should then decide on an acceptable amount of office space per office worker (perhaps 10 m^2). Everyone (from secretary to CEO) then receives a budget for office space (e.g., 300 € per month) and can choose whatever office he or she wants. If it is bigger than the budget, the difference is deducted from the paycheck, if it is smaller, the paycheck will increase accordingly.

5.4 Find an optimal span of control

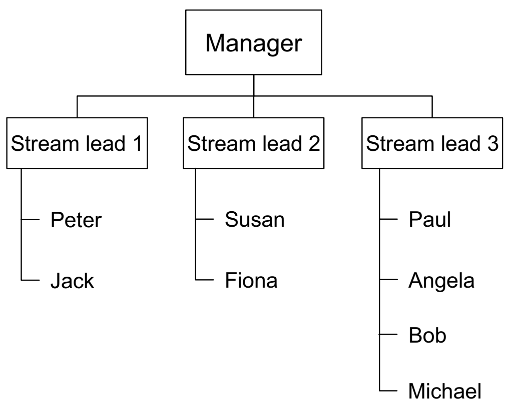
An organizational unit normally has one head (leader, manager, etc.) and "some" subordinates (coworkers). The exact number of subordinates may vary. It is commonly referred to as the "span of control." Obviously, a very small span of control is a waste and a very big span of control is not manageable. How big should an organizational unit be? This subchapter addresses this question.

In section 5.4.1, I will define the exact meaning of span of control. In section 5.4.2, I will discuss a new model. I will show that the span of control must not be as broad as possible. Rather, it should have an *optimal* value.

5.4.1 Definitions and formulas

Consider the organizational chart in Fig. 5-12. The manager has three stream leads. His or her span of control is three. Stream leads one and than the two each have two subordinates. Their span of control is two.

Fig. 5-12: *Organization with <SC> = 11/4*



Stream lead three has four coworkers. His or her span of control is four. The span of control (SC) varies from point to point in the organizational chart. It is a local quantity. One may define a global span of control (<SC>). It is the average of all local spans of control. It can be translated into the following mathematical expression:

$$<SC> = \frac{1}{n}\sum_{i=1}^{n} SC_i$$

Applied to the example of Fig. 5-12, one comes to:

$$<SC_{\text{Fig. 5-12}}> = \frac{1}{4}(3+2+2+4) = \frac{11}{4} = 2.75$$

The global span of control (<SC>) is not necessarily an integer. It is a rational number. The local span of control (SC) is normally an integer. However, part-time workers may be counted in proportion to their working time. In that sense, a stream lead may have a span of control of, say, 5.5. It is quite useful to define two other quantities:

M = number people (managers) leading other people
N = number of people that do not lead anybody

In Fig. 5-12, we have M = 4 (one manager and three stream leads) and N = 2 + 2 + 4 = 8. The total number of people in any organization is M + N. (In Fig. 5-12, the total number of people is 4 + 8 = 12). Using M and N, the following expression can be derived:

$$M = \frac{N-1}{<SC>-1} \approx \frac{N}{<SC>-1}$$

For a proof, see 8.1 Appendix SC. The formula is true for any organizational chart. In Fig. 5-12, one has:

$$M = \frac{8-1}{11/4 - 1} = \frac{7}{7/4} = 4$$

The approximation applies if N is huge compared to 1, which is normally the case. The formula is quite useful if somebody wants to know the average span of control in a very big company. Going through the organizational chart of a company of 100,000 people may be extremely tedious. But most likely the personnel department knows the total number of people (N + M) and the number of people leading somebody else (M). The average span of control, then, is easily calculated:

$$< SC > = \frac{N + M - 1}{M}$$

Please note that all formulas are good only so long as $\langle SC \rangle, N, M > 1$. If $\langle SC \rangle$ approaches one ($\langle SC \rangle \to 1$), then $M \to \infty$. This is quite reasonable, because $\langle SC \rangle \to 1$ would be an aberration. Unless N were equal to 1, there would have to be an infinite chain and therefore $M \to \infty$.

5.4.2 Getting the optimum

General "wisdom" sometimes asserts that the span of control SC should be as big as possible. The logic behind this can be explained with the following example. Let us assume that a company has 10,000 workers to be led (N = 10,000). If the global span of control were 5 one would need M = 9,999/4 ≈ 2,500 managers. If the global span of control were 10 one would need M = 9,999/9 = 1,111 managers. In this example a rise from $\langle SC \rangle = 5$ to $\langle SC \rangle = 10$ will cut 1,389 managerial positions, or roughly 11% of the entire workforce associated with most likely more than 11% of the entire labor cost. Giving on average 10 instead of five subordinates to each manager seems feasible. Therefore, such an increase in the span of control in a company with a low span would seem to be an excellent cost-saving tool. It was used especially extensively throughout the 1990s. Many middle managers lost their jobs. Buzzwords like "lean organization" are closely related to it.

Of course, it is not possible to have an infinite span of control ($\langle SC \rangle \rightarrow \infty$). This would lead to just one manager (M = 1). There have been many arguments about whether it is possible to go to a bigger and bigger span of control leading to more and more cost saving. I will not add anything to this discussion. In what follows, I will prove the following two striking remarks:

- A change in SC hardly changes the head count.
- There is an optimal $SC = SC_{opt.}$. Both $SC < SC_{opt.}$ and $SC > SC_{opt.}$ will lead to a higher workload.

The first point contradicts most "span of control projects" of the 1990s. There is an implicit assumption within these projects, and that is that the boss is doing nothing but leading. Therefore, one needs exactly one manager to lead 5, 10, or 15 people. However, this assumption is plainly wrong. A boss of five people, for example, will probably have time left for other things besides leading. Most likely, he or she will at least partly do the same things as his or her subordinates do. When the number of subordinates is extremely high, meanwhile, the workload for leading is probably so high that an assistant manager is required. Considering the entire workload, one sees that there is hardly any change if the span of control is changing. (Except if SC approaches one.)

This makes it clear that the 1990s cutting of middle management was mostly nonsense. (Middle managers claimed this at the time, but probably for other reasons.) Considering the whole picture will prove the surprising second point above. The starting point for a reasonable model is considering the workload for leading, W_l. It should be as small as possible. In the last paragraph, I have argued that the workload is essentially proportional to the number of people led. That is very plausible, because doubling the number of subordinates will lead to a doubling of evaluations, job assignments, etc. From this one can say that

$$W_l \propto SC \quad \text{or} \quad W_l = B\,SC,$$

where B is a constant (e.g., B = 20 hours per month). As we see, the workload W_l increases with SC while the number of managerial positions (M) decreases with SC. As a result, we calculate the total workload as:

$$W_{ltot} = M \cdot B\ SC = \frac{N-1}{SC-1} \cdot B\ SC$$

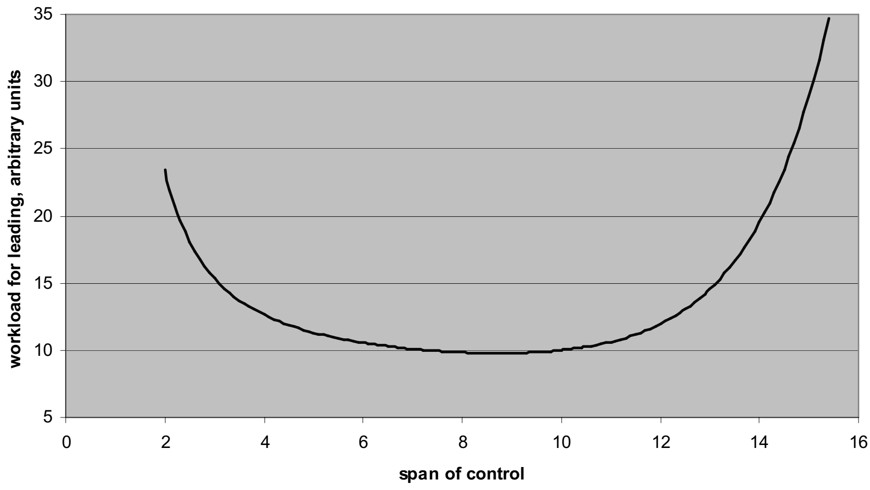
Only if SC comes close to 1 will the entire workload increase dramatically. (It should become clear that W_{ltot} is essentially proportional to N. "Doubling" the company ($N \rightarrow 2\,N$) will probably double W_{ltot}.) For a bigger SC, there is (as argued above) hardly any change. If, for example, SC goes from 10 to 20 (100% increase), the W_{ltot} above will increase by roughly just 5%.

As a result, W_{ltot} will scarcely change with a change in span of control. While this effect is most likely the dominant one, two additional contributions to the workload for leading are present. First, there is a (small) constant part in the workload. Some (few) tasks of a leader may be independent of the number of people he or she leads. Maybe activities like the weekly meeting of the middle managers belong in this category. It will contribute to the entire workload with A times M (A is another constant). Secondly, leading people is to some extent a matter of solving conflicts between two (or maybe more) subordinates. Straightforward mathematics can prove that the number of possible conflicts in a group grows exponentially (base 2) with the group size (see appendix 8.1). It will lead to a contribution in workload that will also grow exponentially with SC. Putting all this together will lead to

$$W_{ltot} = (N-1) \cdot \left(\frac{A}{SC-1} + B \cdot \frac{SC}{SC-1} + C \cdot \frac{2^{SC}}{SC-1} \right)$$

A and C are other constants just like B already introduced above. Even though the values of A, B and C are not known exactly, a very useful conclusion can be drawn. The first term (A/(SC – 1)) would require a large SC for minimum W_{ltot}. The second term (B SC/(SC – 1)) hardly changes W_{ltot} with growing SC, while the last term (C 2^{SC}/(SC – 1)) demands a small SC = 1 + 1/ln2 for minimum W_{ltot}. Even without calculating the SC_{opt}, it is clear that an optimal SC exists. The typical way how W_{ltot} varies with the span of control is shown in Fig. 5-13. There one can see a minimum at about SC = 8.7. Going below or above this optimal figure will increase the workload for leading the organization. Going to greater and greater spans of control will therefore increase the total cost. One can also see that the slope of the curve above the minimum is steeper. In case of doubt, therefore, one should choose a smaller span of control rather than a bigger one. (In Fig. 5-13 SC ≈ 8.7 is optimal with W_{ltot} ≈ 9.8. Going to SC = 5.7 yields

Fig. 5-13: *Typical plot of W_{ltot}*



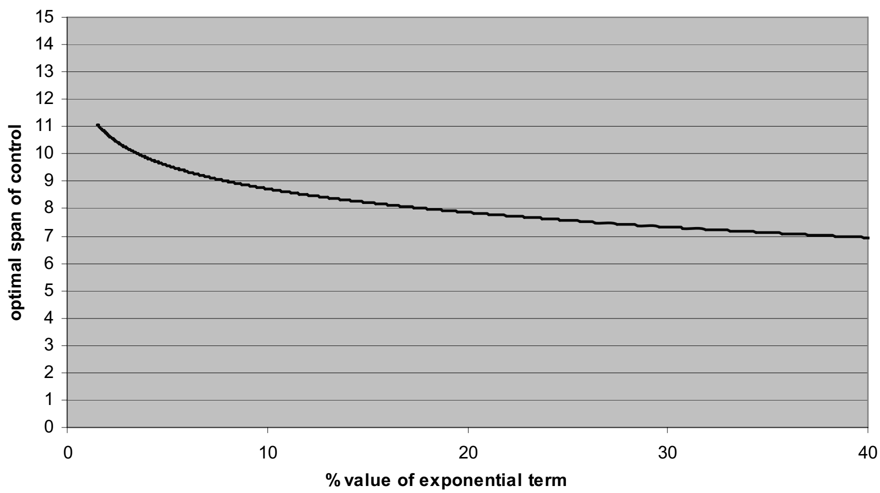
W_{ltot} ≈ 10.7, going to SC =11.7 yields W_{ltot} ≈ 11.5. Having a too small workload will add 9.2% to the minimum workload; a too big one will add 17%.)

Please note that I correctly used the local span of control (SC) rather than the global or average one (<SC>). <SC> has no meaning for minimizing the management workload (W_{ltot}). Even if the <SC> = SC_{opt} one organizational unit is maybe above the optimum and one unit below it, both will add to the overall workload W_{ltot}.

Exact calculations of SC_{opt} are not possible unless the constants A, B, and C are known. However, assuming some reasonable values one finds a very limited range for SC_{opt}. The constant part (A) is probably small. I assumed it to be 10% (at SC = 10), although other values will not change the general picture. With that, one can find the mathematical value of SC_{opt} in dependence of the exponential term (C).

A straightforward calculation yields the numerical solution plotted in Fig. 5-14. Because the "linear" part of the workload (B) should be dominant, the exponential part must be small. From Fig. 5-14 one sees that a 5% exponential part means SC_{opt} = 9.6. Doubling the exponential part to 10% will yield SC_{opt} = 8.7, and tripling will yield SC_{opt} = 8.2. For

Fig. 5-14: *Optimal span of control SC_{opt}*



any reasonable assumption of the exponential part, one will have an optimal span of control of about 8 to 10. In the case of an organizational unit where there is very little or no interaction between its members the exponential part will become extremely small and SC_{opt} quite big. This is the reason why an engineer may lead 20 independent machine workers, because the interaction between these workers is practically zero. It would lead to an infinite SC_{opt}. The limit of, say, SC = 20 is given, because as a practical matter one person cannot supervise a much larger number of people. Aside from such an untypical case as this, the optimal span of control is between eight and 10. In areas with high interaction (e.g., a creative marketing team) SC should be closer to 8. Where the interaction is not so strong (e.g., planning managers in the purchasing department) an SC around 10 should be chosen.

5.5 Using reengineering

Alongside balanced scorecard (BSC), business process reengineering (only sometimes referred to as BPR) is one of the best-known management buzzwords. A Google search yields around 1 million entries for "business process reengineering." It is not the purpose of this subchapter to add anything new to the subject. Ever since its heyday in the 1990s, reengineering has been and is performed by almost any manager and consultant from time to time. Consultancies have claimed to improve reengineering by adding words like "customer-focused reengineering" or "market-driven reengineering." There is even a case of a consultancy registering the term "Business Transformation" as a trademark, then claiming that it is the only consultancy in the world that performs (a) business transformation. All this does not sound like a management tool. It rather sounds more like advertising. And this is exactly what skeptical people see first and last. They claim reengineering is not new. It is just another word for reorganization. Others regard it as identical to cost-saving projects – or just to laying off people. Of course, there is no law on how to define the expression "business process reengineering." People may do as they please and add to the confusion. In this book, I will stick with on the original definition from Michael Hammer in his famous Harvard Business Review paper. In light of this definition, the following two statements are true:

- Reengineering is new and differs substantially from, for example, reorganization.
- Reengineering is very useful.

Both statements are simple conclusions from Michael Hammer's original Harvard Business Review paper. In my opinion, this paper contains all the necessary information about reengineering. The overwhelming flood of secondary and tertiary work has brought with it more confusion than clarification. As I will just repeat here the content of the original work, people having read and understood Michael Hammer's original paper may just skip this section. Others will find in 5.5.1 a useful summary of Hammer's original paper. In 5.5.2, a perhaps amusing example is given. In my opinion, it is best to explain how reengineering differs from reorganization or automation. Some hints for how to deal with reengineering are given in 5.5.3.

5.5.1 Hammer's approach

In the 1980s, automation with the help of IT and especially cheap and powerful PCs began to dominate the office world and partly, too, production. The main goals for using these tools were to boost productivity or lower costs. Sadly, this goal was achieved but very rarely. Exactly that was the starting point for Hammer's work. He explained why it had happened, and how to achieve the desired goal. Even today, however, many people object to the assertion that IT did not reduce costs. The main misperception comes from looking backward at the situation. People consider what is done today with the help of sophisticated IT tools, then they try to imagine what all of this would cost without the use of IT. Consider, for example, a 10-page offer from a consultancy. Today, it is produced with a PC and a laser printer (maybe even in color). The total cost for production (typing and printout) is about €150. Producing an identical document 40 years ago would have required a graphics department with expensive printing machines. The total cost might have been about €1,000. Eliminating a mistake or making a slight change afterwards would probably have almost doubled the cost. From this, one may conclude a cost saving of 85%. The crucial point that is disregarded, however, is that nobody produced such an expensive offer 40 years ago. At that time, it was typed with an ordinary typewriter. Only very simple or no graphics were used. A mistake or slight change was corrected with a ballpoint pen. In the end, that product might also have cost €150. Very similar examples can be found in many other areas. IT improved the quality while costs stayed by and large constant. Some people may argue that the boost in quality increased revenue leading to higher profits in the same way as if costs were saved. However, this is very unlikely. Everybody in business must deliver higher quality today, and so there is no comparative advantage any longer as there might have been in the beginning.

In addition to the argument above, today's IT cost are often not measured correctly. Hardware and software needs service, and people must be trained to use it. Working out an individual problem can easily consume many hours. (While creating this book it took me many hours to place the graphics. As most MS Word users might know, graphics sometimes do not stay at the desired position on the page.) The ERP system from SAP is used for controlling in many companies. But it does not have a module for IT cost controlling. Furthermore, investments in IT are rarely questioned at all. If we were to add in all these hidden costs, one might find that costs are even higher than before.

In order to find a remedy one has to consider the situation more thoroughly. Before the IT revolution, people had a certain business process (cf. chapter 2). Let us say it contained 10 activities. Then they introduced IT. They performed the same 10 activities but with the help of IT. This may have boosted quality, but it did not lower cost. In order to save, one has to perform different activities (normally fewer activities) instead of just performing them differently. Michael Hammer said:

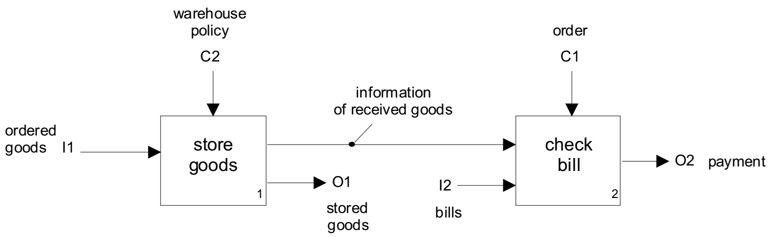
"Don't automate! – Obliterate!"

Reengineering is therefore nothing else than making changes in the process while keeping the final output constant. Here is a trivial example to show the difference. Let us say some traditional process is to make two photocopies, discard one, and file the other. A reengineered version of this process is to make one photocopy and file it. A reorganized version of the process would be that somebody else makes the photocopies, discards one and files the other. An automated version is to scan the document twice, discard one file, and store the other in the PC. Of course, this trivial example will (hopefully) not occur in the real business world. In the real world, things are more complicated. People are unable to see a reengineering possibility easily. Sometimes reengineering (= change of process) is only possible due to IT. Furthermore, the reengineering sometimes makes reorganization necessary. All this contributes to the confusion about reengineering. An amalgamation of reorganization and reengineering is also contained in Michael Hammer's original article.

Case: Bills payable department

Here is a case in point where very dramatic cost savings were possible due to reengineering. A big American automotive company had 250 people working in its central bills payable department. Their essential task was to check the bills and initiate payment if no mistake had been found. A cost reduction of 20% appeared possible by some standard cost-saving approach. That looked fine at first glance, but compared to

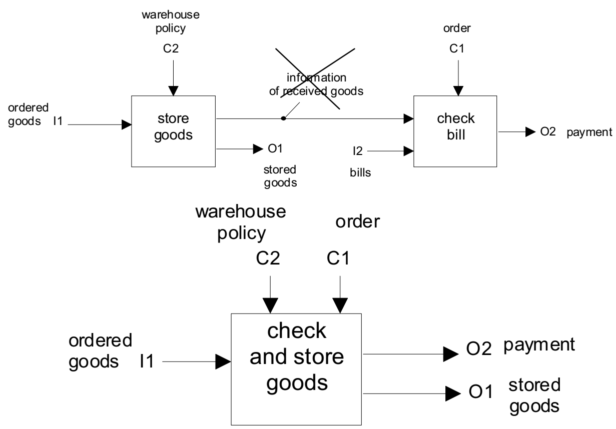
Fig. 5-15: Original purchasing process



a quite similar US-based Japanese competitor it looked lousy. They had five people in their bills payable department. Obviously they did different things, although the final product (= correct bills paid only) was identical. In order to see where reengineering comes into play, consider the (simplified) underlying process. In Fig. 5-15 just two steps are shown. "Store goods" is done by somebody at the warehouse. He or she examines the material for correct quantity and apparent damages. The goods are stored and the information upon correct arrival is given to the bills payable department. In the good old days, this was done by internal surface mail; now it is done by e-mail or by a mouse click in the ERP system. In the second activity ("check bill") the bill is compared with the order (agreed price). If everything is fine, payment will be initiated. In the good old days, once again, somebody wrote a check; nowadays some field will be clicked in the ERP system directly connected to the bank's IT system. As one sees, IT is used extensively today, but the process itself remains identical.

Reengineering requires changing the process. Something should be skipped. In Fig. 5-16 the solution is shown. Now the person at the warehouse is doing both jobs (Considered solely, this is reorganization only.). However, there is no longer any need for the intermediate product "information of received goods." Furthermore, considering the details of the task "store goods" (including checking for quantity and quality) before (Fig. 5-15) and "check and store" afterwards (Fig. 5-16), respectively, one will hardly find any possibility for change in

Fig. 5-16: *Reengineered purchasing process*



workload. It is easy to imagine that the workload will be identical. Before the reengineering the ERP system accessed the order (excluding price) at the warehouse and the person compared the quantity in the order with the actual quantity in the transportation documents (and in reality). Then, in most cases, an okay field is clicked. In the reengineered version, the ERP system is again accessing the order (including the price) and the person is comparing quantity and price instead of quantity only. Again, the okay field is clicked in most cases. It is easy to see that this will increase the workload at the warehouse by almost nothing.

In this case reengineering would not have been possible without an ERP system and a network. In the good old days, the order was in a file cabinet, typically placed between the purchasing and bills payable department. It was impossible for a worker perhaps far away at the gate of a warehouse to access this document. He or she just wrote on the delivery papers whether the delivered quantity was okay. The paper was then sent to the bills payable department.

Although IT made the reengineering described above possible, it took many years to “discover” the cost-saving potential. I am convinced that lack of intelligence is not the reason for it. Even more than a decade after Michael Hammer’s publication, most companies are still not using the reengineered process. In Germany, for example, I do not know a single big company working in the reengineered manner, although all have had sufficiently sophisticated ERP systems for many years. I personally tried to introduce Michael Hammer’s idea to several German companies. I was never successful. First, people said that there are legal problems. Each expenditure must have a bill. Otherwise, else it cannot be booked as a cost. And in the reengineered version there is no bill – just a delivery document. However looking at a typical German delivery document, one will see that it is almost identical to the bill. Just the area where the word “bill” and the price stand is made unreadable by many black marks. Practically every vendor is more than willing to combine the delivery document and bill. It will save the cost of one document. After solving this problem, some quite strange discussion started. In the reengineered process, the person at the warehouse would know the price. But prices are confidential. Although I have never figured out why price data are confidential in the first place, I do not see why the guy at the warehouse is less trustworthy compared to the people in the accounts payable department. Other arguments were that the person in the warehouse must not know the price, because he or she is may be tempted to steal expensive goods. Other theories were that the blue-collar worker at the warehouse must not be enabled to transfer money to the vendors. If he or she wants to harm the company, he or she would initiate the payment even though all goods are completely damaged. Besides the obvious fact that the same criminal intent might also lurk among white-collar workers in the bills payable department, the person at the warehouse could just as easily give false information to the bills payable department. Nobody can prove the quality of the delivered goods there.

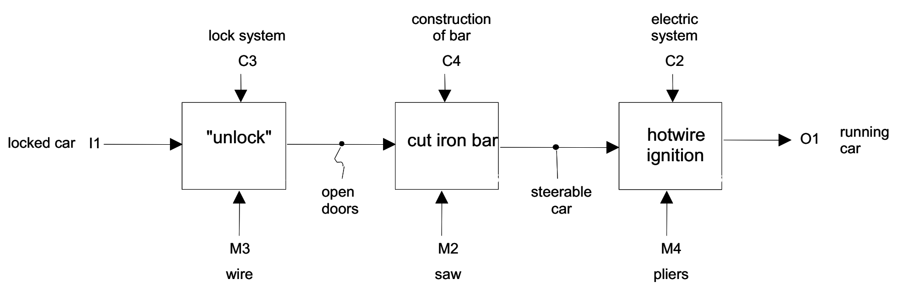
Psychological rather than technical problems make reengineering difficult here. This situation is far from untypical. In this particular case, it was a question of trust. Therefore, it comes as no surprise that a Japanese (though US-based) company had no problem with the reengineered process. In Japan obeying of any kind of rules and loyalty are assumed and mostly present. Therefore, blue-collar and white-collar workers will be equally trusted in Japanese companies.

5.5.2 A non-business example

The example from 5.5.1 is a useful one because it can be applied in almost any company and the potential cost saving is high. For really understanding business process reengineering, however, it is not so suitable. Automation and especially reorganization are mixed with reengineering there. All people who want to see how pure reengineering works should read the following non-business example.

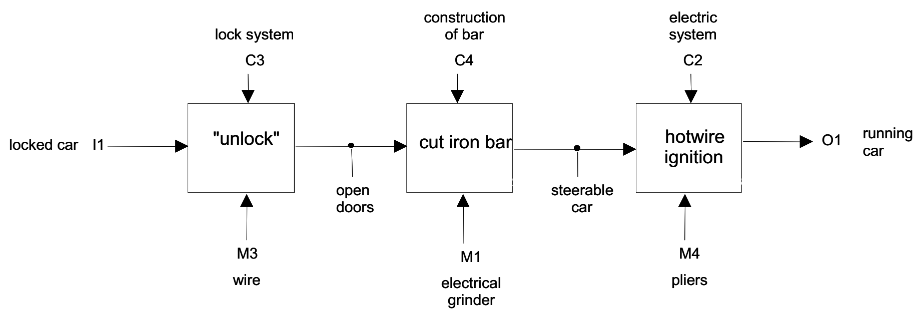
Let us suppose somebody wants to steal a car. (This is normally a business, too, albeit an illegal one.) The car has no electronic blocking

Fig. 5-17: *Traditional car theft*



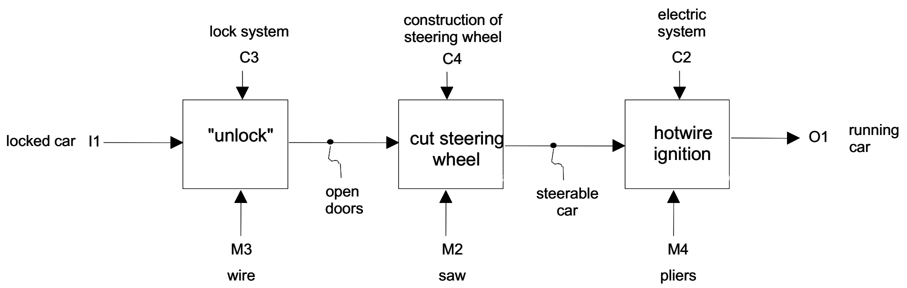
system but there is a steel bar locked between the brake and steering wheel. In order to drive away with the car, the process from Fig. 5-17 must be performed. First, one has to open the locked doors. Then the iron bar must be cut. This leads to a steerable car. Finally, one must hotwire the ignition, resulting in a running car. Before thinking about reengineering here, I will give an example for automation. The iron bar is normally hardened. Cutting it with a saw will take a long time. Therefore, people came up with the idea of using an electrical grinder instead of the saw. Such grinders are available in 12-volt models. They can be plugged into the car's cigar lighter. The automated process is displayed in Fig. 5-18. Everything stayed the same. All intermediate products and activities remain as they were. The achievement is a faster process. However, an investment for the grinder is necessary. Furthermore, an electrical grinder is quite noisy, which fact rather limits its use. The outcome is quite typical for automation. An investment is necessary and the net savings are small. Therefore, one should think of reengineering which is possible without any investment here. In order to find the solution one should concentrate on the necessary products. One does not need a cut iron bar. One does need a steerable car. Therefore, one may come up with the idea of

Fig. 5-18: *Automated car theft*



cutting the steering wheel instead of the iron bar. Both lead to the same result: a steerable car. The advantage of cutting the steering wheel over the iron bar is dramatic. The steering wheel is made from plastic or leather with an aluminum core. It can be cut very easily, and this does not produce any noise. The reengineered process just discussed is displayed in Fig. 5-19. As one sees, the tools are the same (no automation). But one intermediate step has changed. No

Fig. 5-19: *Reengineered car theft*



investment is necessary here. (All three versions of the process were actually performed in reality. People (most likely without any college degrees) performed excellent reengineering without even knowing the word.)

The just discussed reengineering also has nothing to do with reorganization. In all cases, probably one person is performing the entire process. Reorganization would mean here, that one specialist is in charge of the first activity, one for the second, and one for the third.

5.5.3 Applying reengineering

Reengineering means to change the process. The tasks or the intermediate products are changed. It has nothing to with who is performing the tasks (organization) or what tools are applied (automation). In the beginning of this subchapter, I have already explained that automation alone rarely saves costs. Reorganization is also no cost-saving tool. It does not change the workload (cf. also beginning of subchapter 5.3). Changing the process (reengineering) changes the workload. Therefore, it can be an ideal cost-saving tool. For that reason, it looks very smart to scrutinize the processes of a big company in order to find superfluous activities or intermediate products. Many consultancies tried this approach, and especially during the 1990s. They were partly successful. Others brought disgrace to the principle idea of reengineering. At least in hindsight, this outcome is by no means surprising. Very simple possibilities of reengineering can be found nowhere. Obviously, superfluous activities will be discovered by the people involved quite quickly. To find possibilities that are not so obvious involves a great deal of work (on the part of management and maybe of external consultants), but it does not guarantee success. One might need to invest, say, €1 million. From my own experience, I would say that there is about a 50% probability of reaping a substantial return on that investment, but also a 50% chance of losing money. On average, I see an adequate return on investment. So, from a global point of view, reengineering is a good idea. It is quite difficult, however, to predict the odds for a particular project. Here starts the consultant's dilemma. If he or she admits that the result may not be successful, he or she will most likely never sell any project. Therefore, success must at all times be promised. There is no problem in the 50% of positive outcomes. In the other half, the consultant has to "invent" something to make failure or a neutral outcome look like success. It is exactly these projects that led to the opinion held by some that reengineering is plain nonsense.

Reengineering bears some risk, but it promises (on average) high returns on investment. That statement is by no means new in the business world. Taking that risk is the very business of any real entrepreneur. Many consultancies deny this truism. They are maybe clever salespeople, but they are dishonest advisers. Be that as it may, once one has decided upon reengineering three approaches are helpful:

- Look at areas far apart in the process.
- Find (historic) reasons for the present process and examine whether (new) technology has eliminated these reasons.
- Detect areas where personal decisions or rules coerce a certain process.

Looking at areas far apart in the process means regimes where people do not have frequent contact with one other. In these areas, there is a certain likelihood that people are doing identical things instead of sharing information. (Sometimes their activities might even be counterproductive.) I will take an example of this from a producer of consumer goods. There may be a customer service department (closely related to marketing and sales) and an R&D department (closely related to production and engineering). The customer service department writes the owner's manual for the final customers. Meanwhile, the R&D department is in charge of writing a description of how the product should be used for the internal quality control. Both products (descriptions) are perhaps 90% identical. Especially to keeping the documents up to date for many new and old products requires a databank of identical content.

The second point above is to find areas where technology (most likely IT) enables reengineering. I do not suggest looking at areas of new technology, however. As I have shown in Hammer's example (the bills payable department case, 5.5.1), between the introduction of the necessary technology and the eventual reengineering lies easily a decade or more. Therefore, I suggest finding a reason for the actual doing. For any major process area, the following written declaration should be prepared:

Done in this way since: ………………………..………………...
Reason for doing it in this way: ………………………..………………...
Way of doing it previously: ……………………………………

In doing this, one will easily find the areas with potential. The same logic may apply for the third point above, where some soft facts rather than technology are responsible. I do not recommend doing it in the same way as done above. A "reason for doing it in this way" may have an answer like "because a friend's son needed a managerial position." Writing down such statements might have even legal consequences. But even thinking of it is a bad suggestion. More often than not, humans "feel" the thoughts of other people. A positive way is to ask people how they would do a certain process if they were free to decide. One way of doing it is to have a brown paper session (cf. 2.3). I highly recommend asking people who are not directly involved in the particular process. So it might be smart, for example, to ask the personnel department for new ideas for the processes in controlling. Even places not presumed to be a source for new management ideas are worth a try. The worker's council can be an ideal source. They are rarely asked by management for suggestions. I personally found very good hints there.

5.6 Buzzword process organization

Another management buzzword is process organization. With merely around 100,000 entries at Google it is probably less well-known than balanced scorecard or business process reengineering. In contrast to the buzzwords mentioned previously, process organization is by no means new. Only the term is new. To clarify that point is the purpose of this subchapter.

Business processes are the starting point for a process organization. In a big organization, people will find a handful of so-called core processes. These summarize the core activities in the company. In a big consultancy where I used to work, we not only sold process organizations to our clients. We also had one in our own company. The core processes were:

- The people process
- The controlling process
- The marketing process
- The project or consulting process

Each of these processes had a process head or process lead. The processes had subprocesses with corresponding leads, and so forth.

Fig. 5-20: *Process organization*

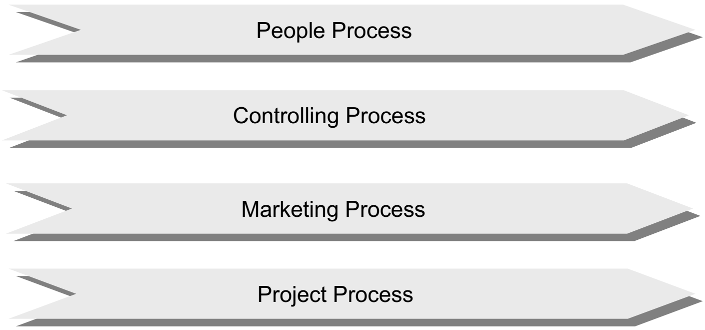
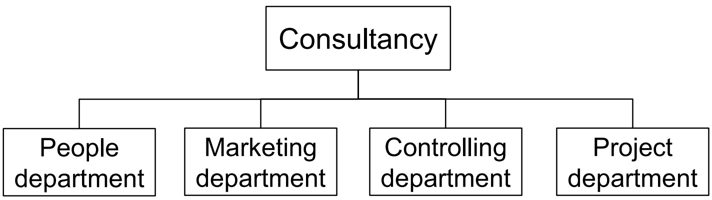


Fig. 5-21: *"Traditional" organizations*



The system was not displayed in a standard organizational chart. A typical graphical display is shown in Fig. 5-20. The horizontal arrangement is intended to demonstrate the difference from traditional hierarchical structures that run vertically. (Sometimes hierarchies are indicated by vertical columns.) Please note that each process has a head. He or she is accountable for all the activities carried out in each process. That is by no means different from the traditional organization. To see the point even more clearly, consider a consultancy with the organization displayed in Fig. 5-21. As long as the activities in the processes of Fig. 5-20 and the corresponding departments of Fig. 5-21, respectively are identical, the so-called process organization is identical to the "traditional" one. To see the point even more clearly, consider a company saying that its core processes were the purchasing process, the production process, and the selling process. Needless to say, their corresponding process organization is identical to the functional organization of Fig. 5-6. From this, it is hopefully clear that a process organization as conventionally seen is at most a marketing gimmick to sell organization projects. It is a typical example in which smart ideas, such as considering processes or having fewer hierarchies, are reworked as a new recipe for success even though the ingredients are barely understood by the chef.

I stated above how the majority defines process organization. However, there is a minority with a different understanding. These people see process organization as a way to achieve an organization. For them, "process organization" is identical to the "process of organizing." In a process organization, one considers the process first. Certain areas of the process are declared "core processes." They are identical to the "bundles of activities" I explained in section 5.2.2. Process organization is seen in contrast to the (faulty) way of constructing the organization from top to bottom (as already mentioned in 5.2.2). This definition of process organization is reasonable. But even here it is not a new invention. It is just a new word for the one and only reasonable way of how to create an organization.

5.7 Myths of self-organization

Self-organization is a buzzword with over 3 million entries at Google. However, it is not limited to business. Most managers and quite a few academics in business have heard of self-organization, but most of them do not know exactly what it is supposed to mean. It is a pretty small crowd that is working on self-organization in business. They are sometimes producing magical, mystical tales. The purpose of this subchapter is to shed some light on this (in my opinion) interesting area.

Based upon the established organization (as defined in this book), everyone in a business is supposed to know what to do and how the processes should be executed. Sometimes people like to do it the way the organization demands, sometimes not. That is one of the reasons one needs to supervise the execution of an organization. Without strict supervision, people will work differently from the ways set out in the organization. Assuming that the official organization describes the best way of doing something, any change will lead to something worse. But, as stated earlier, there is no single best organization and even a quite good one is hard to find. Furthermore, the environment may change and with it the boundary conditions for the organization. In the existence of such new conditions, then, it is in principle possible to change any organization for the better. Nevertheless, letting people do just as they please likely will lead to a poorer situation.

So far, then, self-organization does not look very appealing in business. However, sometimes people do find a better organization when they work as they please. If this mechanism could be properly fostered, it might bring certain rewards. Perhaps one even would find the truly optimal organization. A changing environment would not imply the need for management to change the organization. Rather, like a living organism, the organization would adapt to a changing world. Taking it to the extreme, nobody would need to think about organization anymore. People would simply be introduced to the process, then they would start with no organization and end up with the perfect one without the intervention of management. (About half of all management jobs would then be superfluous – along with about half of this book.)

How to foster self-organization so that it leads to positive effects is therefore of great interest. Up to now, little is known about it. I personally do not think there ever will be a perfect self-organization like the extreme version speculated about in the last paragraph. Nevertheless, I do think it is worth a try. It is one of the very few areas where basic research in management is justified. I will discuss the principle way – and main obstacles – to success in the next paragraphs.

As a starting point, one has to reward people for "right" behavior. A behavior is by definition "right" if it contributes to the general goals of the company, such as maximum profit. Up to now, it looks like the controlling system introduced in chapters 3 and 4. Indeed, I would say that a proper controlling as defined here is the first step towards the positive effects of self-organization. Introducing a sufficiently good controlling, however, is by no means simple. One problem is the reward system. Most people in business might think of a monetary reward system or something like it (more money, more office space, a private secretary), but that does not work everywhere. Consider the situation wherein some parents do the job of educating their children. Some do a good job and, unfortunately, some a lousy one. Even if there were an exact way to measure the quality of education, it would be absolutely wrong to give more government support to good parents. Parents do this job for altruistic reasons. They love their children (hopefully). Moreover, such ways of motivation are not limited to the family. My famous colleague Julian Le Grand has called those people working for monetary rewards "knaves" and the more altruistically motivated ones "knights." In areas such as caring for the elderly or in our schools, one will find quite a few knights. Investment banking, meanwhile, is properly dominated by knaves. In any case, one has to expect both types everywhere. Depending on the particular job, one should foster knightly or knavish behavior.

But there is a more fundamental problem to solve. Even if everybody is "correctly" motivated, he or she will merely do what is best at his or her particular point in the process. Self-organization is an extreme form of decentralized organization. As I have shown earlier, it leads to local optima rather than the global, company-wide optimum. A reward system driven by what is best for the success of the entire company is hard to find. But even if it were installed, it would not work. Situations that are good for the company as a whole but bad for the individual would demand too much from the individual. Just imagine a situation where the best local move of a worker would be to leave the company. Perhaps a bit of conventional management could be put into play at this locus to give him or her a push, but then the very idea of self-organization would be destroyed.

So much for the interesting and valuable ideas of self-organization. Now I will comment on the ludicrous ideas. A perfect organization could be termed a highly ordered system. An organization less than perfect, then, is a less ordered system. A lousy organization, or none at all, could be called a completely disordered system. High organization corresponds to low disorder and little organization to high disorder. So far, this is just another wording for the same thing. But let us introduce another word: εντϱoπυ (entropy). It comes to us from the Greeks, and it essentially means disorder. Using it here, we can say:

In self-organization, the entropy may decrease.

Still there is nothing new up to now. Just the words changed. In order to understand the ludicrous part, I must make a small diversion into physics. In thermodynamics, the so-called second postulate introduces this word entropy. The postulate claims that there exists a function of the extensive parameters with certain properties (not of interest here). This function is called entropy. It is a well-defined quantity. The third postulate in thermodynamics claims that this entropy is additive and will always increase. Another area of physics is called statistical mechanics. There people define entropy as the logarithm of the number of possible quantum mechanical states. One can show that this entropy will always increase too. Furthermore, the entropy from thermodynamics and statistical mechanics are identical.

So, my diversion into the world of physics has shown us that entropy is a well-defined quantity and it will always increase. Obviously, the word entropy has at least two meanings – one in management and one in physics. Just as the word dough means “raw material for pies” for some people, it is a synonym for money to others. Economists may fashion a law that says money in the bank will never bear negative interest (decrease). Translated into informal language, such law could be stated as “dough in the bank never decreases.” It would be ludicrous if a baker with his dough claims he has discovered an economic system of possibly negative interest rates. But exactly such a mix-up occurs with the entropy. In management, the entropy may increase or decrease. That does not violate the third postulate of thermodynamics, however, because there it is a differently defined entropy that will always increase. Claims such as “self-organization proves thermodynamics wrong” ought to be the stuff of jokes and comedy shows, just as some jokes play on the multiple meanings of the word dough. Unfortunately, even some academics volunteer as comedians without even recognizing it.

6 Quantitative tools

In this chapter, I will discuss tools for quantitative analysis. Politicians talk quite often about the economy. They prefer words like "good," "nice," and "fine." They rarely deal with exact quantities (numbers). And if they use numbers, they quite often lack skillfulness (e.g., speaking of "increase in GDP" instead of "increase in GDP per capita." The same is at least sometimes true for managers. The closer one looks to the top in an organization, it sometimes seems, the weaker is the ability to work with numbers. Helping to overcome this deficit is the reason for this chapter.

Standard textbooks for business majors are full of quantitative tools, but the proper application of these tools rather lags behind. Since such tools are available in abundance, it is obvious that something prevents people from using them properly. I think there are two reasons:

- Some general skills are missing.
- Choosing the right tool (from a large number), is a difficult decision.

Both reasons have to do with the fact that "knowing a tool" and "understanding a tool" are two different things. I will stress the understanding here. Subchapters 6.1 and 6.2 deal with such basic problems. Subchapters 6.3 and 6.4 are examples of proper use. I have chosen these examples because I think they are quite useful. Moreover, I have used them quite frequently and with great success in the forms presented here. In the last subchapter (6.5 "Commenting on chaos"), I will touch upon an area where science intersects with management. It provides a reason to question many quantitative analyses. The subject discussed there is fundamentally very important, but it is a field where basic research is still needed.

6.1 Dealing with numbers and errors

This subchapter has two sections. The first section (6.1.1) discusses how to deal with numbers, and especially how to define them. The second section (6.1.2) discusses the often forgotten fact that all quantities have a margin of error. Taking this into account makes many standard cost calculation procedures look quite dubious.

6.1.1 How to define measures

Quantitative analysis is often helpful in management. Using gut feeling alone or judging by words like “good” or “bad” is rarely sufficient. Perhaps due to the blossoming of IT, the last 20 years saw rapid growth in the quantity of measures used for analysis. These start with the simple old ones, such as revenue or profit, and extend to such newer ones as EBIT or EVA. I will neither explain them here nor will I define a new set of measures. Judging from my own experience, such ready-made measures are rarely useful in a given operational situation. At top level, they are more or less useful. Therefore, investment bankers and analysts are using them successfully. But in a given business situation one has to define measures individually. These numbers are nothing but controlling variables, as discussed in chapters 3 and 4. As I have shown there, they are derived from the general goals (quite universal) *and* the underlying detailed business processes (which vary greatly). Therefore, even middle managers have to define their own measures.

There are two essential ingredients for an apt number:

- The measures should express the information of interest.
- The measure should be comparable to others.

Although both points might appear to be self-evident, they are quite often disregarded. As a negative example of the first point, I remember a discussion about introducing certain ERP systems to companies of medium size. Of course, it is reasonable to ask from which size a particular company needs a certain ERP system. A typical question asked is: "Above which (annual) revenue is your ERP system useful?" Although the reasons as to why this question arises is pretty clear, it is completely senseless. The ERP system helps to run the administrative process, but having 10 times the revenue does not necessarily imply 10 times as much administration. Now, having 10 times more employees in the company probably *does* have such an implication. Therefore, "number of people" is much more useful for establishing a threshold for introducing a certain ERP system. (Of course, more thorough considerations should be taken into account for introducing an ERP system.)

Therefore, one should choose a measure that has a direct relation to the question under consideration. The measure "revenue" is often cited. But it is hard to derive some useful information from it. It is always possible to create a business with arbitrary revenue as long as one needs not to bother with profit. In order to define a proper number, one should first state a concrete question. For example: "Will I be able to finance my bank loan this year?" A measure yielding the information to answer that question should have the following property: If that number changes, does it have a direct consequence for the answer to the question asked? Or, is it possible to change this number without any consequences for the answer. In the example of the bank loan, one easily sees that revenue is not a qualifying quantity here. Even a 10-fold increase in revenue may or may not lead to cash for financing a loan. Cash flow is most likely the measure of choice here.

Having properly defined a measure, one wants to compare it to a stated goal or to data from other businesses. Profit might be a reasonable quantity for many purposes. It appears natural to maximize profit. However, is it really a good thing if the new boss doubles the profit of a big company within two years? Maybe he bought some scarcely profitable companies. In doing so, he or she might have increased the total profit, but the return on investment (ROI) may have decreased. Most likely, such an increase in profit is not in the interest of the shareholders. That does not mean that ROI is always the first choice instead of profit. Consider, for example, a big law firm with quite a few partners. They are of course interested in profit. But ROI is not much useful there, because there are hardly any big investments necessary. There, the quantity of choice is properly profit per partner.

As one can see, one quantity of interest may vary with another quantity of interest. Mathematically spoken, the first is a function of the second. So, profit may vary with investment or with the number of partners. In most cases, one assumes a linear or almost linear relationship. In such cases, one has numbers in the form "quantity per something." Examples are "profit per employee" or "profit per invested capital." Only such relatively defined numbers can be compared.

However, there are some situations in which the business world is nonlinear. The expression of interest may have the general form

$$p = p(x)$$

In order to compare two or more p-values to one another, it is important to consider the value of x. To compare two companies, one must not just consider just the quotient p/x but the differential quotient

$$\frac{\partial p(x)}{\partial x}$$

Considering and comparing such differential quotients is the most general approach, but the practical usefulness is quite limited. This is because the functions p(x) are rarely known. In what follows, I will give two examples from the nonlinear world. One is from daily life, the other from business. In both cases, it is possible to build quotients that are just slightly more complicated but not so much so as differential quotients.

Case: Person's weight

As an indicator for health and fitness, the weight of a person is a useful quantity. However, it is useless to say that a person of 85 kg (187 lb) is obese. If he or she is 160 cm (5′ 3′′) tall, then that individual probably is obese. Measuring 195 cm (6′ 2′′), in contrast, may imply a perfect body. There is a rule of thumb to take the height into account. The rule calls for taking the height in centimeters and subtract 100. This should be the maximum weight in kg (or 10% less for the ideal weight). Obviously, this rule is complete nonsense for people less than 100 cm (3′ 3′′) tall. A more elaborate measure used by the World Health Organization to judge about obesity is the BMI (body mass index). WHO divides the person's weight by the squared height. As an example, somebody has BMI = 85 kg/(1.95 m)^2 = 22.4 kg/m^2. If the BMI is above a certain number, the person is obese. If it is below another number, the person is undernourished.

I have stated two methods to define measures in order to judge about obesity. Which one is correct, or at least better? The short answer is that both are incorrect but the BMI is slightly better. A human being is a three dimensional thing. Its weight scales with the volume. Therefore, a correct number must have the dimension mass per volume (e.g., kg/m^3 or lb/ft^3). A perfect body scaled up by, say, 20% in height has every measure scaled up 20%. The weight will not increase by a factor of 1.2 but by 1.2 x 1.2 x 1.2. Therefore, one has

$$weight = constant \cdot height^3$$

If this constant is above a certain value, the person is obese. If it is below a certain value, the person is too skinny. To comparing relative obesity among people, one should compare the weight divided by the third power of the height. For normal-sized adults the BMI is a reasonable approximation to the formula and the rule of thumb stated above is a rougher approximation.

Case: Number of vendors

And now to an example from the business world. It is quite common to analyze a purchasing department to determine the proper number of vendors. Of course, that number depends upon the purchasing strategy – such as global sourcing or single sourcing. Furthermore, it depends upon the industry under consideration. But within a given industry and an assumed strategy, people tend to compare the number of vendors. Let us suppose that one machine-building company (A) with a global sourcing strategy has 1,500 vendors while another one (B) has 3,000. Assuming that A has a reasonable number of vendors, one might declare that B has too many. (Too many vendors keep the purchasing department unduly busy, and the prices tend to be too high.) Although such benchmarks are in reality established quite often, one should consider the situation more thoroughly. The number of vendors depends also upon the size of the company, or better upon its purchasing volume. But it is not a linear relationship. Therefore, the number of vendors divided by purchasing volume is not a reasonable quantity either. A doubled volume justifies fewer than a doubled number of vendors. At least part of the new volume can be purchased from the old vendors. In appendix 8.2, calculus is used to derive the following formula:

$$NOV = constant \cdot \sqrt{V}$$

NOV denotes the number of vendors and V the purchasing volume. Comparing the number of vendors of two purchasing departments, one should use

$$NOV \Big/ \sqrt{V}$$

as the quantity of choice. If in the example above company B had fourfold the purchasing volume of A, then both companies would have the same relative number of vendors.

6.1.2 Taking into account the margin of error

In the last section, I have shown how to define measures properly. In this one, I will show how to calculate with numbers. In most business situations, it is sufficient to use the four basic calculations (+, –, *, and /). However, even their proper use is rarely found. This surprising statement has to do with the fact that *every* measured or observed quantity (number) has a certain margin of error. Instead of just writing "a," one ought to write

$$a = \langle a \rangle \pm \Delta a$$

where <a> denotes the average or medium value of a and Δa its variation. Instead of having a cost of €10 one may have €10 ± €1. Some people claim that their errors are small and may therefore be disregarded. But it is dubious to claim small errors while not considering them. Especially if simple calculations are performed, errors may go up or down. To see this, one has to know how to calculate with numbers showing certain errors. If one has a number b with

$$b = \langle b \rangle \pm \Delta b$$

some people simply write

$$a + b = \langle a \rangle + \langle b \rangle \pm \left(\Delta a + \Delta b\right)$$

In general, this is plainly wrong. The misunderstanding comes from an incorrect interpretation of the meaning of "margin of error." Some think that it is the regime of total variation and in each calculation one should try to find the minimum and maximum possible value. Of course, it is possible to take such approach, but it will lead to bigger and bigger margins of error. More importantly, it is by no means sensible. Even if two quantities vary with equal probability between certain values, it is very unlikely that both take the maximum or minimum simultaneously. Therefore, the absolute minimum or absolute maximum values are quite unlikely. Furthermore, quantities do not normally stay in an absolute limited regime. The production cost of something may be €10, but if something goes wrong it will cost maybe €11. If the machine breaks down, however, it may imply a cost of €10,000 in total. The latter assumption is possible, but very unlikely. This is very typical for almost any quantity one deals with. A cost of €10 ± €1 normally means that the cost stays between €9 and €11 within a certain probability. (It is a question of judgment as to how high this probability is set.) Normally, values around the average have a higher probability than do values lying far from it. As an example, one may think of a Gaussian distribution in the so-called bell curve. Keeping an image of this sort in your mind probably will help you to imagine the things discussed here. I must note, though, that not everything said here is limited to Gaussian distributions.

In light of the just-stated interpretation of "margin of error," one can see that the formula above normally overstates the total margin of error. A straightforward calculation yields

$$a + b = \langle a \rangle + \langle b \rangle \pm \sqrt{\Delta a^2 + \Delta b^2}$$

For a proof of the formula, see appendix 8.3. A formula is also derived there for the product of a and b. Please note that the formula is only true if the two errors are uncorrelated. If they *are* correlated, then the formula shown above is much too restrictive. When two errors are correlated, their deviations become large and small in unison. They do not average out. The result is a much bigger total error:

$$a + b = \langle a \rangle + \langle b \rangle \pm (|\Delta a| + |\Delta b|)$$

The following case gives an archetypal example of this for a typical business situation.

Case: Calculation of automotive parts

A company produces gears for car transmissions. These are forged from metal blocks. Automotive companies are infamous for bargaining prices. That means profit margins for gears are extremely small, maybe around 1% or even less. Therefore, a very precise cost calculation should be performed. Let us assume a particular gear has a production cost of €1.20. In addition to those for production, there are costs for sales and administration. This so-called overhead was estimated to be 60% on top of the production costs. Therefore, the total cost of the gear is €1.20 x 1.6 = €1.92. The gear was sold to an automotive company for just €1.93.

The head of production was aware that his cost calculation contained some margin of error. He had evidence that the variation was about ± 1 cent here. With cost of €1.21 € x 1.6 = €1.936 they would make a loss of over half a cent per piece. Therefore, he looked for ways to improve the accuracy. Most promising was to install a separate electricity counter for each machine. Cost for energy is quite high in forging. With such energy counters on each machine, he was confident to be able to reduce the margin of error to about 0.1 cent. Then he could prove whether they were making a loss or not. The quite substantial investment for the energy counters appeared to be justified.

Though a margin of error was taken into account here, a substantial mistake had been made. The margin of error for the production cost is not the only one. The overhead of 60% is a very rough guess. Though its margin of error is difficult to determine exactly, a qualified guess was that the real overhead may lie between 30% and 90%. Therefore, the total cost per gear must be calculated as

$$(€1.2 \pm €0.01) \cdot (1.6 \pm 0.3)$$

The two errors are uncorrelated and the total cost is

$$€1.92 \pm \sqrt{€^2 0.016^2 + €^2 0.36^2 + €^2 0.003^2} \approx 1.92\ € \pm 0.3604\ €$$

Despite increasing the accuracy of the production cost calculation by tenfold, as suggested by the head of production, the calculation remains almost identical:

$$€1.92 \pm \sqrt{€^2 0.0016^2 + €^2 0.36^2 + €^2 0.0003^2} \approx 1.92\ € \pm 0.360004\ €$$

The sad point is that both calculations came to the conclusion that it is absolutely unclear whether they are making a profit on that gear or not. In this case, I told the head of production that it was absolutely a waste of money to increase the accuracy in the calculation of the production cost. He "sort of" understood my message. But he said: "Well it is not the desired accuracy. But we are a little bit closer to it." (The reader may judge for himself or herself whether ± 0.360004 is any better than ± 0.3604. It is a typical example of what caused Carl Friedrich Gauss (1777–1855), arguably one of the greatest mathematicians (and scientists and engineers) ever, to remark: "Durch nichts wird mathematisches Unvermögen deutlicher als durch übergroße Genauigkeit im Zahlenrechnen." [in English: "Nothing proves mathematical inability better than excessive precision while calculating with numbers."])

In order to fix the problem above, one needs a more accurate way to calculate the *overhead* cost. One way to achieve it is to introduce activity-based costing (cf. subchapter 6.3). The accuracy demanded here is very difficult to achieve, however. Let us suppose that the production cost is known with an accuracy of ± 0.1 cent. Then one has to demand the following:

$$(€1.2 \pm €0.001) \cdot (1.6 \pm x) = €1.92 \pm €0.01$$

x stands for the accuracy of the overhead calculated with activity-based costing. The total error is set to be the profit margin in order to make sure no loss is made. Using our expression for multiplying errors we have

$$€1.92 \pm \sqrt{€^2 1.44 \cdot x^2 + €^2 0.0016^2 + €^2 0.001^2 \cdot x^2} = €1.92 \pm €0.01$$

This quadratic equation in x is easily solved. The result is x ≈ 0.0082. This is an accuracy of about 0.5%. Because such accuracy appears to be impossible for areas like sales and general administration to achieve, the company described above has no possibility to prove whether it is making profit or loss with a particular part. Although this is an unhappy conclusion, it would have been ludicrous to perform elaborate cost calculations while ignoring the facts.

6.2 Applying semi-quantitative methods

In management, one has to make decisions. They are always in the form of whether to do A or B. In principle, the answer is quite simple. In most cases, it is correct to say: “Do whatever will eventually lead to the bigger profit.” Sometimes, though, it is very difficult to calculate the expected profit. Needless to say, one should try as hard as possible. But if it is truly impossible, then other methods are required. Experience and gut feeling must sometimes be called into play – and I should stress that this is by no means a bad method. On the contrary, it is probably the best one. This demands really solid experience and good gut feeling, though, and such qualities are hard to find.

Especially young people or those new in a certain business will not have such qualities. Nor can they calculate the expected profit any better than can anyone else. As a substitute, they think about what things will contribute to the profit and make a list of them. The list will contain criteria such as, for example, market share, product quality, or risk of competition. Then they will assign say zero to 10 points to each criterion in accordance with how much each criterion will show a (positive) effect. Summing up the points, one will reach a number that looks just as precise as a calculated profit. Using this score is what I call a semi-quantitative method.

In what follows, I will comment on when such methods should be used or not used. Then I will discuss how one should create semi-quantitative measures. I will comment especially on typical mistakes.

The result from a semi-quantitative measure is a relative indicator. A higher score means, for example, a higher potential profit. But it is not an absolute measure. Therefore, it is quite reasonable to compare two scores based upon the same criteria and evaluation procedure. Comparing semi-quantitative measures that are different from one another would, of course, be nonsense. Nevertheless and unfortunately, a very special form of just this occurs quite often. Some people compare real quantitative measures with semi-quantitative ones. An example of this is to invest a certain amount of money for implementing a strategy that scores high in a particular semi-quantitative measure. In such instance, the invested capital has a real currency measure, but the return on that capital is measured by a relative number. This is like calculating a return on investment (ROI) where the return and the investment are measured in different currencies but one has no clue about the conversion rate. Another negative example is quite often found in logistics. There, a semi-quantitative analysis might have shown that being able to deliver or delivering on time is “most important” for the customer. The result is used as a justification to invest a certain amount of money into the logistics process. (Sometimes even stranger conclusions are drawn.

Because the ability to deliver and to deliver on time is extremely important, people translate it into a 100% ability to deliver and 100% punctuality. And they honestly mean 100% and not maybe something like 99.9%. Taking that seriously implies infinite cost.)

Now I will comment on how to prepare such a semi-quantitative analysis. A typical example is given in Fig. 6-1. There, five criteria are chosen. If all five are fulfilled perfectly, the score is 5, and if they are

Fig. 6-1: *Semi-quantitative analysis*

	weight	0	1	2	3	4	5
criterion 1	3	□	□	□	□	■	□
criterion 2	2	□	□	■	□	□	□
criterion 3	2	□	□	□	■	□	□
criterion 4	1	■	□	□	□	□	□
criterion 5	3	□	□	□	□	□	■
average				■ (3.36)			

not fulfilled at all it is 0. Because each criterion has differently importance, weighting between 1 and 3 has been introduced. On a weighted basis, the average score is 3.36. Instead of the average score one may use the total score. It is 37 in the example of Fig. 6-1. The procedure of Fig. 6-1 may be applied to three different strategies. The one with the highest score is declared the best.

The procedure is simple and seems to deliver clear-cut results. However, the average of 3.36 (or, more precisely, 3.36363636…) gives an impression of accuracy that is by no means justified. Asking different people to judge on the criteria in Fig. 6-1 will lead to different weights and different scores. Probably, even the same people would answer differently if asked again at some later time. In principle, a detailed error analysis should be applied. Using the result from 6.1.2, an error can be calculated. To get an impression, just calculate the results if each score and weight were one point less or more (if possible). The corresponding averages are 2.38 and 3.57, respectively.

In addition to the error from assigning the scores and defining the weights, there is a certain amount of arbitrariness in stating the criteria. By choosing a certain subset of criteria, a particular strategy will probably win or lose. There are even cases where people deliberately choose certain criteria or define weights in order that their favored strategies will win.

Instead of just adding the scores, as done above, one may multiply them. This is sometimes done without further reasoning. Should doing so be allowed? When should it be done? These questions are rarely asked or answered. In the case of Fig. 6-1, the total score will be zero if the scores are multiplied, because one factor (criterion 4) is zero. Normally one will not allow a score of zero in order to avoid such an extreme result. But even without there being a score of zero, the results tend to drift further apart when multiplication is used instead of addition. Exactly this is sometimes used as an argument for multiplication, as it makes clearer which strategy scores highest. But should such a thing be permitted? If outcomes are so very close together that one scarcely can make a decision, should one be allowed to use mathematics to move them further apart? The answer is a strict "no." Not only is such multiplication unreasonable, it also contains a fundamental mistake. To see this, one should remember that the scores are a substitute for some real measure. Quite often, that measure is profit. Please note that real measures are expressed in some unit. In the case of profit, it is a monetary unit, such as €. In any case, the score does have a certain unit (something like x points equals one € leading to a gauge factor of 1/x €/point). When multiplying these units the dimension will have a certain power (e.g., $€^5$), but such dimension has no meaning at all. Therefore, the only proper way to use multiplication is to take the corresponding root afterwards. (When n numbers are multiplied one has to take the nth root afterwards.) Although this is an absolute necessity, I have never seen it done in reality. In order to show what I mean, I will give a detailed example below.

Let us suppose one has three strategies – A, B and C – to decide between. One chooses five criteria on the basis of which to find the best strategy. Assigning scores to each criterion for each strategy yields the result in Fig. 6-2. As one sees in the sum and average of the summation, the results for strategies A, B and C differ by around 10%. The pure product shows differences of over 100%, which are artificial.

Fig. 6-2: *Semi-quantitative analysis of strategies A, B and C*

	score on strategies			
	A	**B**	**C**	
criterion 1	1	3	5	
criterion 2	4	3	3	
criterion 3	3	3	5	
criterion 4	2	3	2	
criterion 5	3	3	1	
Sum	13	15	16	
average of sum	**2.60**	**3.00**	**3.20**	
Product	72	243	150	nonsense!
5^{th} root of product	**2.35**	**3.00**	**2.72**	

The fifth root of the product again shows results differing by around 10%, which is reasonable. But there is another important difference between the summation and multiplication. By summing the scores, strategy C wins. Multiplying makes strategy B the winner. Strategy C has, on average, the higher score, but strategy B is more homogeneous. Multiplication gives credit to a homogeneous result. If homogeneity is important, as it sometimes very reasonable is, then this is a very good reason to choose multiplication. If, for example, all the criteria are about customer satisfaction or quality, then a very high score in one criterion does not fully compensate for a low score somewhere else.

The average of the sum is also called the arithmetic average. There the average quadratic error is minimal. The root of the product is called the geometric average. If all the scores are identical (as for strategy B of Fig. 6-2), then the geometric and arithmetic averages are identical. In all other cases, the geometric average is smaller. While the arithmetic average works for both positive and negative scores, the geometric average is defined for positive scores only. Weighing certain criteria is also possible in the geometric average. The weight of criteria must be taken as an exponent of each criterion score. As an example, the geometric average of Fig. 6-1 is

$$\sqrt[11]{4^3 \cdot 2^2 \cdot 3^2 \cdot 0^1 \cdot 5^3}$$

As mentioned previously, this average is zero. Because some people do not like such results, the zero is rarely included as a possible criterion score when dealing with geometric averages. However, it is by no means unreasonable to do so. Sometimes one has criteria that all should show at least some value. If that is the case, then a geometric average is a perfect overall measure. Consider grades at university as an example. Typically, if a student fails in even one required subject he or she will not be awarded a degree. In such case, denoting a failed subject with a zero and using a geometric average is superior to an arithmetic average. The only requirement is an average grade bigger than zero. Taking the geometric average of grades is reasonable for other reasons, too, by the way. A student of a certain field is educated in certain subjects because people assume that these *all* are necessary. Therefore, a student with a homogenous knowledge is superior to a student with a very good knowledge in one subject but almost none in another. (Please note that this does not contradict specialization. The specialization takes place by choosing a certain field for study, but the individual subjects within this field are defined as the minimum scope.)

6.3 Preparing activity-based costing

Activity-based costing, or ABC, is in general well known. Almost any book in the broad field of cost calculation will comment on it. Here a very practical approach is chosen. In addition to a brief summary, I will describe how to *prepare* ABC in real-life situations. If one begins with advanced theoretical models, this can quickly lead to complicated procedures in the real world, and, understandably, this has convinced quite a few people that activity-based costing is not worth the effort. Quite in contrast, I will show that simple versions of ABC can create little extra workload but huge benefits.

To summarize what activity-based costing means, I have to say that ABC is neither new nor a smart "invention." Rather, it is just common sense. More than a few management academics will object to this remark. In order to understand my statement I recommend teaching ABC to an engineer. In production, there is a detailed (technical) process. Perhaps one starts with a sheet of metal. Some holes are drilled in it, the metal is bent, and so forth. If an engineer wants to calculate the production costs, he or she starts with the cost of the raw material. Then the engineer will look at the activities carried out. The cost of each activity must be determined. Summing up these costs will lead to the production cost. As an example, consider the activity "to drill a hole." The time for drilling will be essentially proportional to the product of diameter and thickness of metal sheet plus some fixed time for handling. The time so determined will lead to labor cost and machine usage.

An engineer would never use any other method to calculate production cost. Outside production the situation is often very different. In all factories in the world, some raw material is transformed (first activity) and the product is sold to the customer (second activity). *All* people in a factory are there to support these two activities. The people in production are doing it very directly. People in the personnel or controlling department are doing it very indirectly.

(Unfortunately, some people are not doing it at all.) The total cost of a product includes the costs of these direct and indirect activities. While it is straightforward to determine the direct costs, it is puzzling to do the same for indirect costs. Most often, the following method is used for the indirect costs. If the total direct costs of an entire company are X and the total indirect costs are Y, then one uses the quotient Y/X as a factor to account for indirect cost. For example consider a product with direct production cost of €3. Then its total cost is €3 * (1 + Y/X). The factor Y/X is commonly referred to as *overhead*. By definition, the overhead is on average exact. In any particular case, it can be too low or too high. As long as this error remains reasonably small, this is a very suitable approach. Provided that the overhead is small (e.g., 10% or Y/X = 0.1) one does not expect a huge error. However, such small overheads rarely exist in reality. An overhead of, say, 60% is by no means high. There are many (big) companies having overheads of far more then 100%. In such cases, one cannot rely on the cost calculation at all. Especially any sophisticated calculation of the direct costs is a waste (cf. the gears case in 6.1.2).

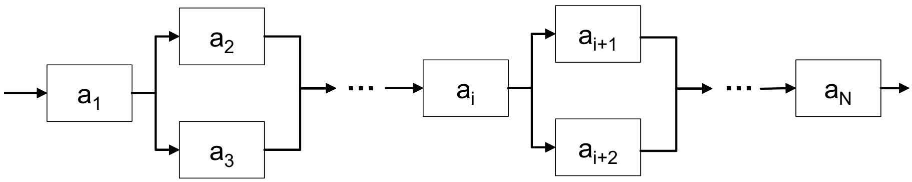
Probably more than half of all companies have very inaccurate cost calculations as described in the previous paragraph. But not all are suffering from it. If profit margins are sufficiently high, then knowing costs is not essential. In what follows, I will briefly comment on the "theory" of ABC (6.3.1). Then I will give an example where a reasonably simplified version is used (6.3.2). I will close this subchapter discussing why ABC is still so rarely found (6.3.3).

6.3.1 Theory of ABC

As stated above, there is no real "theory" of ABC. For an engineer it may be considered common sense. Nevertheless, I will describe the procedure here in an abstract form. This is useful in order to learn some frequently used terms. Furthermore, it can demonstrate the huge workload of applying ABC in a very detailed manner.

The starting point is in the activities performed. They constitute nothing but the process model. A process with N activities a_1 to a_N is displayed in Fig. 6-3. Chapter 2 explains how to create such a process model. No special process language (e.g., SADT or ARIS) is required here. To each activity, a cost driver d and a cost factor c must be assigned. The cost driver d is something that relates to the cost or workload via a linear function. (For nonlinear considerations, see

Fig. 6-3: *Arbitrary process with N activities*



appendix 8.4.) Consider, for example, the activity "sign bills." The workload and cost of such activity is proportional to the number of bills to be signed. (I refer here just to signing the bill not verifying it.) Therefore, the cost driver d here is the "number of bills." The gross time for signing the bill may be 5 seconds. Depending on the salary of the bill signer, it may translate into a cost of 4 cents per signature. This "4 cents/bill" is the cost factor c for the activity "sign bills." Please note that a cost factor always has a dimension "currency unit per cost driver." The same must be done for each and every activity in the process. It is also possible to have more then one cost driver and cost factor for each activity. Consider as an example the activity "prepare bills." There may be a certain time required to handle the bill which is independent of the content of the bill (e.g., writing the address), and there may be a workload for each item on the bill. If this is the case, then one has two cost drivers. One is the number of bills and the other is the number of items on a bill. Both cost drivers have their own cost

factors. Depending on the time for performing the activity, one may have the cost factors of say 5 €/bill and 1 €/item. Please note that the same cost driver may occur many times within one process (e.g., number of bills), but the corresponding cost factors may differ from activity to activity (e.g., 4 cents/bill and 5 €/bill).

The total cost for a product is then the sum of the cost for each activity necessary to be performed. Some activities must be performed several times, others not at all. Therefore, it makes sense to introduce a number n which denotes how often an activity is performed. For people who love to see mathematical expressions, the total cost C_x for a product or service x can be written as

$$C_x = \sum_{i=1}^{N} \sum_{j=1}^{M_i} D_i(a_i) \cdot n_{ix} \cdot c_{ij}$$

($D_i(a_i)$ are the values of the cost driver d_i for the particular activity a_i. The matrix element n_{ix} denotes how often activity a_i must be performed for product x, and the matrix element c_{ij} is the j^{th} of M_i cost factors for the i^{th} activity.)

The perhaps complicated expression above is not, in and of itself, the main difficulty of ABC. The problem with such a fundamental approach is the huge workload behind modeling the process and finding the particular cost drivers and factors. The process must be modeled in such a way that one finds clear-cut cost drivers. It was easy for the aforementioned activity "sign bill." This is an activity at the very detailed level. For an activity at top level, such as "to manufacture a car," finding a proper cost driver is difficult. If one were to choose "number of cars" as the cost driver, one would neglect the fact that different cars have varying costs of production. If the desired accuracy is not too high, however, the cost driver "number of cars" may be suitable here. Having identified the cost drivers ,one has to find the corresponding cost factors (see below for details). Though each step is pretty simple here, the number of steps to prepare a general ABC is very large. In a big company, one may have to consider 1,000 activities. Even if each activity has only one cost factor, 1,000 such factors must be found. Large companies produce easily a couple of thousand different products. Therefore, there are easily over a *million* matrix elements n_{ix}. All these data must be created in the first place, but then costs may change. Furthermore, the underlying process may change. Consequently, even a very carefully prepared ABC needs a complete overhaul roughly once a year. IT tools are sometimes advertised as being very helpful, but they scarcely contribute to reducing the effort. Software for displaying processes permits assigning a cost factor to each activity. Software vendors often show how the cost is calculated in their laptops by just pressing one button. However, the laptop only adds up the costs of all activities. Defining the process model in the first place and assigning proper cost factors must be done "by hand," so to speak. The only reasonable way out is the extremely simplified version presented in the next section 6.3.2.

Before closing this section, I will comment on how to determine cost factors. There are two possible approaches:

- calculate the cost factor from the *button up* (cf. also 5.3.1)
- derive the cost factor from the *top down*

For reasons unclear to me, most people in business use the button-up approach. It is the way I estimated the cost factor of 4 cents/bill for signing. Taking this approach, one starts with the time necessary to perform the activity. It translates that into the labor cost and machine usage. One may add material cost, if necessary. Doing so looks very fundamental, and it is the only way to estimate cost for a planned (not yet real) process. However, the result is most likely fundamentally wrong. To test this approach, one may calculate the entire cost for, say, one year. The result can be compared with the actual cost data from accounting. A difference of 50% is not untypical. In most cases, the total cost of the ABC result is lower than the real total cost. If these are, say, 40% lower, people will normally multiply each cost factor by a so called gauge factor of 1.4. In doing so, the total cost becomes correct. However, the cost for an individual product may still be incorrect. The order of magnitude of the error is typically in the range of the gauge factor (here 40%). The reasons for such huge margins of error are easy to determine. First, the time to perform an activity may be approximately correct, but a slight mistake in each and every activity may add up to a huge error. Second, there are activities which are normally not considered. Examples are "to go to the toilet," "to drink coffee and chat with a colleague" (Which can be extremely useful!), "to watch a wonderful sunset," or just "to be idle" because the boss did not assign any work. Because these activities are hard to pin down, they are normally neglected. The result is a too low total cost estimate.

The second approach (top-down) avoids these problems. Consider, for example, a person working in sales. He or she may perform two activities. One is "to visit customers" and the other is "to manage orders." The person may cost 100,000 € per year in total. He or she is 150 days per year in the office and 70 days out in the field. Then the activity "to manage orders" consumes 100,000 €/year times 150/220 or 68,181.82 € per year. Using the same logic, the activity "to visit customers" consumes €31,818.18 annually. If he or she manages 500 orders and visits 150 customers, the corresponding cost factors are 136.36 €/order and 212.12 €/visit. (The result is correct as long as the customers are very close by. Otherwise, the travel expenses should be considered in the activity "to visit customers.") Obviously, this approach will always yield the correct total cost. Therefore, it should be used whenever possible. The only reason to choosing the bottom-up approach is that no total cost data are yet available for the process.

6.3.2 A simplified version

A very strict and rigorous application of ABC implies a huge workload for its administration. In most cases, the cost for ABC will exceed the benefits. But that does not mean that ABC is useless. Typically, the problem is especially that cost accountants want to be too precise. Choosing an *appropriate* precision is the key to success. Nevertheless, I have to admit that there is no straightforward way to determine what is *appropriate*. In the real example below, some gut feeling was used, but that, in my opinion, is a necessary prerequisite for a manager.

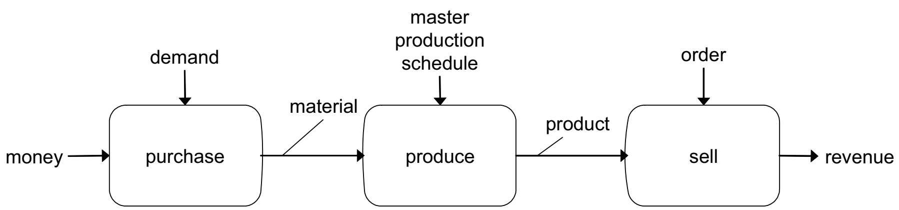
The most simplified version of ABC is the ordinary overhead as mentioned in the introduction to this subchapter (6.3). In that case, one assumes that all indirect activities only one and the same cost driver. All indirect costs are supposed to be driven by the cost of the direct activities. Under this approach, such costs as for insurance or risk are reasonably distributed. Generally speaking, this approach is appropriate as long as the effort for indirect activities is proportional to the effort for direct activities. Therefore, the overhead approach sometimes works quite well. Consider a purchasing department as an example. It typically charges 5% of the material cost as an overhead to cover its purchasing activities. As long as very similar materials are bought, this approach works quite well for the operative purchasing activities. It fails, however, when these goods are very different. While 100,000 (identical) light bulbs may cost the same as one car, the effort of buying a car is very different from that for acquiring 100,000 (identical) light bulbs. The overhead approach becomes completely incorrect for purchasing activities like "to bargain the price." There, lots of effort in bargaining will (hopefully) lead to lower prices and, therefore, lower overhead payments.

Now I come to a slightly more advanced usage of ABC. It is a real case that is already known from subchapter 4.4.

Case: ABC at aluminum tube welding

A company produced and sold welded aluminum tubes. Its cost calculation was even simpler than the overhead approach discussed above, and everything was measured in tons. The firm produced, say, 20,000 tons of aluminum tubes per year and had total costs of €100 million. Total costs were thus 5 €/kg. This approach was obviously very simple. The sales force especially loved this method, because it was very easy for a salesperson to set a price. The approach was not all bad, either. About 60% of all costs were due to the raw material, which was a special sort of aluminum. Therefore, about 60% of all costs were considered correctly. As long as the total profit is high enough, one can live with such an approach. Two things changed the situation. First, competition grew and market prices correspondingly slumped. Second, the market demanded thinner and thinner tubes. While the material costs were always proportional to the weight, the remaining costs were not. Therefore, the 5 €/kg approach became less and less accurate. Furthermore, more and more customers demanded tubes that were, for example, bent or had holes in them. This extra work had nothing to do with the weight. In order to avoid complicated process modeling and a definition of many cost drivers, the entire process was assumed to have only three steps:

Fig. 6-4: *Three steps of manufacturing aluminum tubes*



One has to find cost drivers for each of the three steps. Then the total cost must be determined, which leads to cost factors by dividing through the appropriate volume measures for each driver. For the first step (purchase) the cost driver was weight. The second step (produce) had two cost drivers. The main one was length. The welding machines for the tubes worked essentially with a constant velocity of about 100 m/minute. Therefore, the total length was proportional to the production cost (labor and machine usage). The extra work for bending or drilling, for example, had to be calculated according to the time it took. Therefore, the second cost driver for production was time. The last step (sell) was assumed to contain all the other activities from order management to controlling. All people involved with such activities were interviewed. They had to describe what is responsible for increasing their workload. Almost all said that, in essence, the number of orders determined their workload. From this it was reasonable to assume "number of orders" as a cost driver here. In order to find the cost factors one had simply to fill out the table in Fig. 6-5.

Fig. 6-5: *Calculation of cost factors*

	cost driver	total cost	total volume	Cost factor
purchase	weight	€60 million	20,000,000 kg	3 €/kg
produce	length	€28 million	100,000,000 m	0.28 €/m
	time	€2 million	800,000 min.	2.50 €/min.
sell	orders	€10 million	10,000 orders	1,000 €/order

I have discussed above the cost drivers in Fig. 6-5. The four values for total cost are standard controlling data. The same is true for the total volumes. Dividing total cost by total volume leads to the cost factors in the last column of Fig. 6-5. Using these cost factors, it is quite simple to calculate the cost of a given order. In order to see the difference in cost calculation between the old 5 €/kg approach and the new ABC method, I have put three real orders into the table of Fig. 6-6. For all three orders the weight, length and time of the mechanical work must be known. The selling price can be compared to the calculated cost in order to determine the profit or loss. For the old costs one has simply to multiply the weight by 5 €/kg. The cost from the ABC method (last column in Fig. 6-6) is easily calculated with the help of the cost factors in Fig. 6-5. (Every reader should perform this little exercise by himself or herself.) Using the old cost calculation, order #1 was deemed highly

Fig. 6-6: *Comparison of old and ABC cost calculations*

	weight	length	time	price	old cost	ABC cost
#1	1,000 kg	10 km	300 min.	€7,500	€5,000	€7,550
#2	2,000 kg	10 km	100 min.	€10,000	€10,000	€10,050
#3	2,500 kg	12 km	0	€12,000	€12,500	€11,860

profitable (50% profit margin!). Order #2 was neutral, and the last order (#3) made a loss. Applying ABC changed this picture dramatically. The highly profitable order #1 produced a loss in reality, and the loss-making order #3 produced at least a small profit.

The introduction of ABC was highly successful in this case. It showed quite accurately which orders produced profits and which losses. (Of course, the loss making orders should have been avoided under either calculation.) The method was also quite simple so that the salespeople in the field could perform the calculations by themselves. Nevertheless, the greatest resistance against introducing this new cost calculation came from the salespeople. The boss of the sales force was especially set against it. He had been the best salesperson for many years, because he acquired many orders like order #1 in Fig. 6-6. This was the very reason that he was the boss of the sales department. ABC proved that his orders rarely produced any profit at all. He understandably feared the new transparency. From my own experience, such fears are the biggest obstacles when it comes to implementing ABC. A good dose of psychology, properly administered, is necessary in order to remove such obstacles.

6.3.3 Reasons not to choose ABC

Considering the reasoning above, every company should have ABC. That is especially clear if one considers the simplified version in 6.3.2.

ABC produces an extra workload, however, and so one should be able to point to a real benefit from using ABC. In any case, ABC does not by itself solve any problem. It merely helps to pinpoint the problem's source. In the case of the last section, it helped to show which order was profitable and which was not. That alone does not create more profit. Only if the sales force is able to choose whether to take order A or B will it be helpful. In the case from section 6.3.2, as that entire factory suffered from overcapacity, every salesperson was damned to acquire any order so long as the cost for material of about 3 €/kg would be recovered. Becoming profitable required a new product strategy. ABC was very helpful to test whether a new product strategy would be profitable or not. Only in this sense was it a tool to increase profits (in the long run).

To take a particular negative example of applying ABC, I remember a big project in an automotive company. In that case, a bunch of consultants had been hired to find out the true profitability of the different models. The consultants applied ABC and did a good job. Of course, their project was much more complex than the simple case in 6.3.2. (It also consumed quite some consulting fees.) The result was striking to the management. The company was profitable overall, and so were most of the models sold. However, one of the most expensive models (a convertible) was a serious loss maker. One could argue that production of this model should have ceased immediately. Taking this argument to an extreme, though, one could say that efforts should be concentrated only on manufacturing the most profitable model. However, there were two reasons why no model could be discontinued:

- Marketing demanded to keep most models (especially that convertible one) in order to preserve the value of the brand.
- The company suffered severely from overcapacity.

The first point is understandable, especially if the company wants to remain a global player. In the automotive industry, it is hard to see how to survive while offering only a handful of models (unless one serves a niche market of, say, super luxurious cars). The second reason for not changing the product portfolio is also understandable. Overcapacity was, and is, a problem of almost all automotive companies worldwide. So, if a company discontinues offering a particular model, then the sales volume of the other models will increase by an amount less than the revenue lost from the terminated model. Due to the fixed costs (see also below), the total profit will most likely shrink. The main problem here was that both reasons had been well known for a long time. Therefore, applying ABC was a pure waste of resources.

Another problem in any cost calculation relates to fixed costs. These costs stay constant even though the volume is changing. A typical example is depreciation. It remains (essentially) constant whether something is used or not. The remaining costs are the variable costs (typically material cost). So, as long as one does not reach 100% of the capacity, one should continue to sell as long as the price is higher than the variable costs. The main problem, however, is to know whether one will reach 100% of capacity within a certain time period. Nobody knows how much he or she will sell tomorrow.

Another problem with fixed costs is the difficulty in defining these exactly. Whether costs are fixed or not depend on the time scale considered. Over a very short time, all costs are fixed. Even the costs for material are fixed, if the material is already ordered and one does not wait until this material has been used. In contrast, on a very long time scale all costs are variable. Over a decade or longer even depreciation for a building is not considered a fixed cost.

Quite a few companies encounter their main difficulties in cost calculation because of fixed costs. ABC does not help in the least when dealing with fixed costs. If the cost factor is determined by dividing total cost by the volume from the cost driver, then it contains all fixed costs. The fixed costs, then, cannot be distinguished from the variable costs. Some people might even think that they have disappeared, which is of course not the case. Then one still has a severe problem but perhaps does not even notice it. Needless to say, ABC produces more harm than usefulness in such a case. (Please note, by the way, that a cost factor that includes fixed costs is no longer linear. For further reference, see appendix 8.4.)

6.4 Using target costing

If somebody produces a product or delivers a service, then market pressure will from time to time necessitate a cost cutting. Analyzing the market indicates the total amount of cost cutting necessary. (If most of the competitors are 20% cheaper, then you probably should be too.) This total amount of cost cutting determines the target cost. So, obtaining the (total) target cost is quite simple. There are two remaining questions, however:

- How to find specific ideas for cost cutting?
- To what extent is it allowed to change my product?

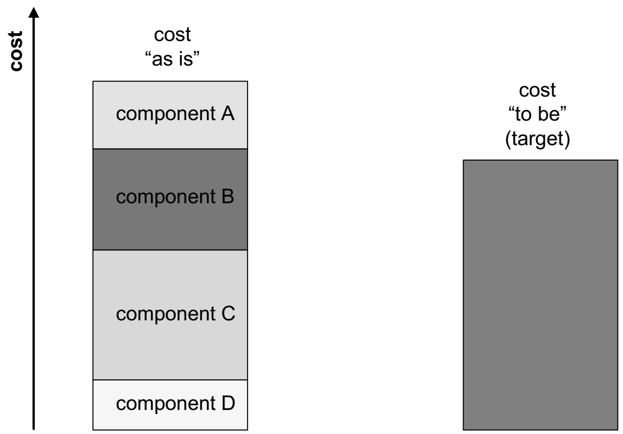
The first question is not addressed by target costing. Needless to say, there is no general idea or tool guaranteeing a cost cutting of x%. If everything remains unchanged, however, then it is a truism that cost cutting will not occur. Therefore, something must be changed. Most likely, such change will also change your product or service (at least slightly). Thus, one should find areas where a change in the product or service hurts least. That is the essence of the second question and the very idea of target costing. One should find features of a product or service in relation to which cost savings can be achieved with the least impact on the customer. (Maybe the cost savings even have no impact on the customer or, ideally, the product is actually improved in the eyes of the customers.)

In this subchapter, a detailed and straightforward tool will be introduced. I have to stress that it is one tool of many, and I do not claim that it is the best. However, it is a tool that I have used personally and with considerable success. In 6.4.1, I will briefly explain the "theoretical" idea of this tool. A detailed, albeit simple, example is given in 6.4.2.

6.4.1 The basic idea

The starting point is the present product or service. Its components or parts are assumed to be well known (especially their costs). If this is not the case, then applying activity-based costing (6.3) will lead to the necessary cost data. Normally, market pressure dictates what the product or service should cost in total. In Fig. 6-7, the necessary data

Fig. 6-7: *Starting situation for target costing*



are displayed graphically. The result of target costing is the "to be" cost of the components (right-hand side of Fig. 6-7). The simplest version of target costing would be to ask your customer which component is most important and which is least. Then the least important component bears the greatest burden of cost reduction. Target costing follows exactly this line of argumentation, although in a more sophisticated and detailed way.

First, one must define the product's features from the customers' perspective. The customer does not necessarily see the technical components, such as hardened gears in a gearbox. He or she values features such as durability. Typically, marketing and sales are able to define such a list easily. Each feature should be assigned a weight measuring its importance. This weight should be set in accordance with the customers' requirements and according to whether the company's own quality in that area is higher or lower than the market average. As a result, one will obtain a list of features with weights w_{fi}:

product feature 1 – w_{f1}
product feature 2 – w_{f2}
product feature 3 – w_{f3}
…

(The sum of all w_{fi} should be 1.) As a second step, one has to find product functions that influence the product features. These are the technical things that contribute to the required features. If durability is a feature, then the alloy of the metals used may be a product function influencing this feature. Of course, one must find a list of product functions, and each and every one of these will influence the product features. People from research and development, engineering, and production are probably best suited to define such a list of product functions. They also should determine how important a particular product function is for a product feature. If one has N product features and M product functions, then one has to find a matrix of M x N scores indicating the importance of the product function i on the weight j. Multiplying these scores of importance with the weights will result in a list of product functions and their importance. (Mathematically spoken, one needs to multiply the one dimensional matrix of the w_{fi}

with the two dimensional N x M matrix of scores.) As a result, one will receive a list of product functions and their relative importance I_{fi}:

product function 1 – I_{f1}
product function 2 – I_{f2}
product function 3 – I_{f3}
…

(The sum of all I_{fi} should be 1.) With this list in hand, the third step can follow. Now one must consider the original components of the product. Again, one has to define scores indicating how much the quality of a certain product function influences the production cost of a certain component. People from production and controlling are probably best for this last step. These scores build an M x P matrix (assuming that there are P components). Just as described above, the matrix elements must be multiplied with the relative importance measures I_{fi}. The result is a list of components and how much their production costs influence the product features important for the customer:

component A – C_A
component B – C_B
component C – C_C
…

(The sum of all Cs should be 1.) Now the final goal is almost in sight. If the total target cost for the product is X, then its component A may cost $X{\cdot}C_A$, its component B $X{\cdot}C_B$, and so forth.

The advantage of this perhaps complicated looking procedure is in its systematic approach. There are three well defined and differentiated steps in which judgments are made. Each step can be performed by a group of people that is quite homogeneous. They will come to a mutual agreement quickly. Combining the three steps is accomplished mathematically. The result is a compromise involving a broad range of opinions, but there is little cause for lengthy arguments along the way.

6.4.2 An example

In real life examples, a product may contain 10 to 100 essential components. Furthermore, target costing has to be performed for many products and not just one. Therefore, a typical example will deal with 10 to 20 products having 10 to 100 components. Although the work is quite straightforward, it can be extremely time consuming. For obvious reasons, I will present here a very simple example that is most suitable for understanding the procedure.

My product is a wheel for a car having the components tire, rim, and warehouse space. The last "component" needs some explanation. The wheel is a product, but closely related to this product is the service of rapidly delivering the wheel. A wheel delivered the next day is

Fig. 6-8: *Given cost distribution of wheel*

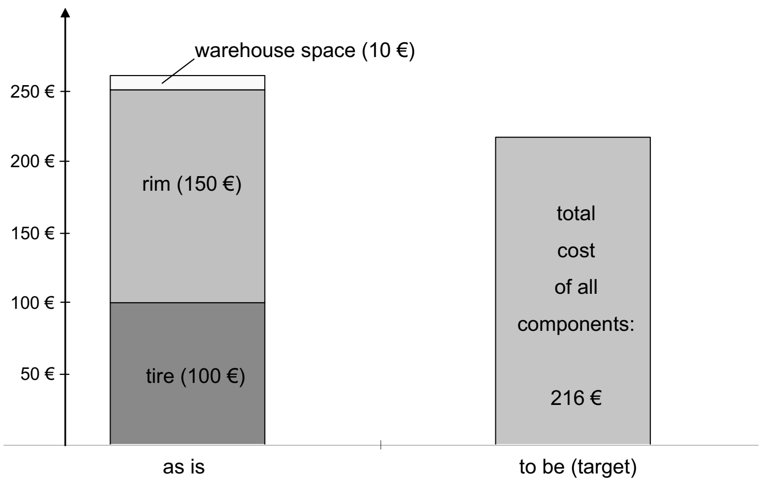


Fig. 6-9: *Evaluation of product features versus product functions (I_{fi})*

	considering the market			score[2] of product functions										
product features	weight of customer	competitor is[1]...	total weight w_{fi}	composition of rubber	profile	aluminum alloy	shape of rim	number of places stored						
durability	20%	better	0.28	5	1	3	1	0						
safety	40%	slightly better	0.48	3	5	0	1	0						
design	30%	equal	0.30	1	2	3	5	0						
delivery time	10%	equal	0.10	1	0	0	0	5						
			0											
			0											
			0											
			0											
			0											
			0											
			0											
	100%			**29%**	**30%**	**16%**	**20%**	**5%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**

[2] scores:
0 = no influence
1 = slight influence
3 = medium influence
5 = strong influence

[1] choices:
equal (factor 1)
slighly better (factor 1.2)
better (factor 1.4)
much better (factor 1.6)

different from a wheel with a delivery time of 1 week. These service components are becoming more and more important in today's world. Therefore, I deliberately included a service component in order to show that target costing works for products, services, and mixtures of both. Fig. 6-8 summarizes the data. The entire wheel costs €260. Its target cost is €216. What are the "to be" costs of the components?

One has to define the product features first. From the customer's perspective, these are durability, safety, design, and delivery time. Theproduct functions are composition of rubber, profile, aluminum alloy, shape of rim, and number of places stored. In Fig. 6-9, I have filled in the product features and the product functions. The four product features show the weights of 20%, 30%, 40%, and 10%, respectively, in the eye of the average customer. The competitor is stronger on some features (e.g., slightly better on safety), and so those features are assigned additional weight through an extra factor (e.g., 1.2 here). Upon adjusting product features as appropriate, the final weights for the four product features come to 0.28, 0.48, 0.30, and 0.10, respectively. They are the product of the original weight times the extra factor (e.g. 0.28 = 0.2 * 1.4). They do not sum up to 1.

Now the product features must be connected to the product functions – such as composition of rubber – in a second step. In Fig. 6-9 the possible choices are from 0 (no influence) to 5 (strong influence). The composition of the rubber, for example, has a strong influence on the durability of the wheel. Therefore, I have assigned it a "5." In contrast, the profile has only slight influence on durability, which leads to a "1" in the corresponding field. All these scores are multiplied with the weights of the product features (0.28, 0.48, 0.30, and 0.10, respectively) leading to the importance measures for the product functions (29%, 30%, 16%, 20%, and 5% in this case). Please note that pure multiplication would lead to different results. Instead of 29%, for example, one would reach

$$5 \cdot 0.28 + 3 \cdot 0.48 + 1 \cdot 0.3 + 1 \cdot 0.1 = 3.24 \quad or \quad 324\%$$

But this calculation must be performed for all others first. Then the result must be normalized so that the sum is 100%.

Now the third step may follow. In it, the importance measures of the product functions (29%, 30%, 16%, 20%, and 5% here) must be connected to the target costs of the components. In Fig. 6-10, the product functions and their importance measures are taken from Fig. 6-9. Then a score of how much the quality of the product functions influence the production cost of the components must be assigned. As an example, take the composition of the rubber. It has a strong influence on the production cost of the tire. Therefore, a score of 5 is assigned there. The composition of the rubber does not influence the production cost of the rim or the cost for warehouse space, however, so zeros are assigned to it in those columns. The assigned scores must be multiplied by the importance measures. The results must be normalized so that they sum to 100%. The result is a target cost distribution for tire, rim, and warehouse space of 46%, 48% and 6%, respectively. The result can be displayed graphically as in Fig. 6-11. According to the market requirements, the tire should stay as it is. The rim was "overengineered." Its cost of €150 was not fully appreciated by the market. The target cost of the rim is just €103. The cost for warehouse space increased by 30%. Obviously, the market demanded a much shorter delivery time.

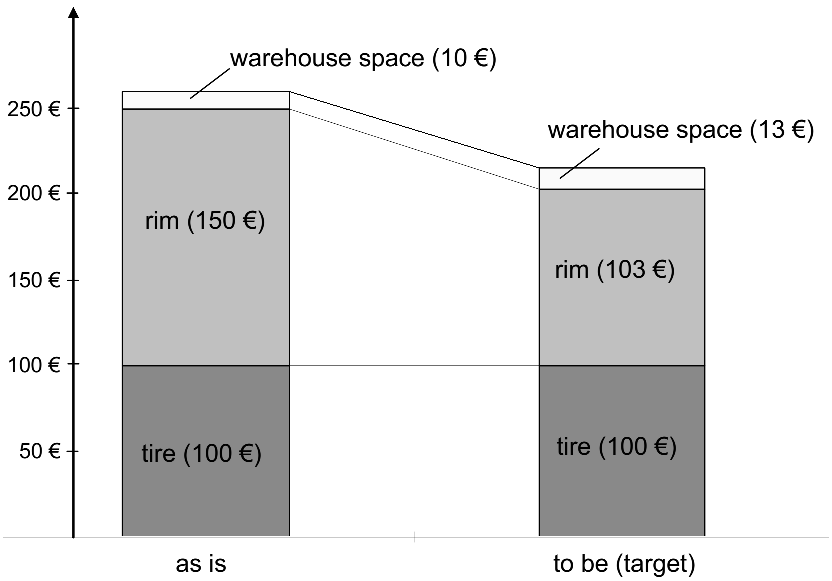
So much for the example. Real-life situations are identical in principle but are much more complicated. Because this example did not require many calculations no computer or software are necessary to perform them. In realistic situations, probably everybody will use some IT to handle the problem. I highly recommend creating an individual software tool, just as I did some time ago. (The MS Excel sheets of Fig. 6-9 and Fig. 6-10 are from my tool.) Of course, the individual content will vary. Especially score and weight factors may be defined differently. I should emphasize, however, that the values defined here worked well in many cases. Of course, there are software tools for

Fig. 6-10: *Connection between importance measures and component costs*

product functions	measure of importance	tire	rim	warehouse space												
		score[2] of influence of functions on components														
composition of rubber	29%	5	0	0												
profile	30%	1	0	0												
aluminum alloy	16%	0	5	0												
shape of rim	20%	0	5	0												
number of places stored	5%	0	0	5												
0	0%															
0	0%															
0	0%															
0	0%															
0	0%															
0	0%															
cost distribution in accordance with market requirements:		**47%**	**47%**	**6%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**

[2] scores:
0 = no influence
1 = slight influence
3 = medium influence
5 = strong influence

Fig. 6-11: *As is cost distribution and target costs*



target costing on the market. However, I do not recommend using them. Just punching in numbers will lead to results that may be correct, but they will not be understood, and understanding is very important when dealing with target costing. Target costing only tells what something should cost. It does not tell how to achieve those costs. The person in charge of implementing the cost change will have more or less difficulties in doing so. If the way that the target costs have been calculated is not transparent, then he or she will simply claim that the software tool producing such data is not working properly.

6.5 Commenting on chaos

This subchapter will lead to the frontier of basic research in the business world. Even at the academic level, management provides few places for basic research – and especially if compared to science. Chaos may be one of the few areas in management where basic research is possible and, more importantly, very useful.

Please note that I do not refer here to chaos in the sense of "I had a chaotic day." The chaos used here is a theory showing that planning and forecasting have limits for *fundamental* reasons. An outcome could be, for example, that a supply chain network of a certain length and structure is impossible to handle (not difficult or complex, but fundamentally impossible). For this reason, every manager must have some understanding of chaos and its effects. It has implications for almost every field of management. I should note, by the way, that the research on chaos in management is still in its infancy.

The rest of this subchapter is organized as follows. In 6.5.1, I will briefly explain how scientists understand chaos. While there is nothing "new" in this section, for nonscientists it is probably a necessary introduction. Section 6.5.2 shows that chaos is not limited to the area of science. In 6.5.3, I show how to handle chaotic situations in business. It is exactly there that one will meet the aforementioned frontier. Even in science, the question of how to handle chaos is far from being answered.

6.5.1 Chaos in science

Merriam-Webster's dictionary defines chaos as "a state of utter confusion" or "a confused mass or mixture." In science (especially mathematics or physics), chaos has a special meaning, although it is not contradictory to the common one. The word chaos comes originally from (ancient) Greek. There the word Χαοσ meant originally "empty space, void." The Roman influence changed the meaning to "disordered mass." The latter meaning can still be found in, for example, the Christian mythology, as in the book of Genesis it is written that God created heaven and earth from chaos. Our word "gas" also has its origin in the word Χαοσ. Historically, gas was very difficult to describe, because it moves around "chaotically." Indeed, the roughly 300,000,000,000,000,000,000 molecules in a cubic centimeter of air do move around very chaotically (in the sense of modern science). Their overall behavior is nevertheless easy to describe in most situations. (This is an example where chaos is easy to handle, which subject will be discussed further below in 6.5.3.) Although the word chaos is very old and the phenomenon has existed ever since the universe was born, science's consideration of chaos is quite new. Arguably, it was Edward Lorenz of MIT who founded the science of chaos in the early 1960s. He scrutinized the numerical procedures of the weather forecast and found that short-term weather forecasting is always possible, although one may need a big computer. (So big that even today's supercomputers reach their limits.) In contrast, long-term weather forecasting is virtually impossible. The explanation for this is quite simple. In order to forecast tomorrow's weather one must know the present weather conditions. These are the initial conditions. Knowing how the winds are blowing today (and other quantities), one can calculate the weather for any later point in time by applying classical mechanics. (Please note that while the principles are easy, the computations are horribly complex.) If the initial conditions (today's weather data) are not given precisely, the forecast will show a corresponding margin of error. That is by no means surprising. If somebody wants to calculate how far a thrown stone will fly, he or she has to know the starting velocity. If the starting velocity is known within a certain margin of error only, then the length of the flight path, too, will be known only within a certain margin of error. At least for small margins of error, one expects to see a linear relationship between the error in the initial conditions and that in the final result. Such a relationship is definitely true for the simple case of a thrown stone. In the more complicated case of the weather forecast, time is likely to prove strange a forecast result made today. Forecasting for a couple of days works fine, but to predict the weather for, say, 30 days from now, one must know the initial conditions *very* accurately. This "very" means that, for example, the little turbulence due to the flying of a butterfly has a severe influence on whether it will rain in 30 days or 31 days. This effect is known as the "butterfly wing effect." Because nobody can possibly know such little things as how the butterflies are flying today, long-term weather forecasting is impossible. Please note that the *principle* of causality is by no means violated here. If one knew all the initial conditions exactly, then one could make an exact weather forecast for an arbitrarily long time. The weather for a longer time *is* predicted today, but its calculation is *practically* impossible. In this context, it is amusing to note that some governments force their (normally state-owned) meteorology departments to perform long-term weather forecasts. This is complete nonsense. Meteorology departments probably do not talk about it much, because this brings in funding. Certain industries, such as that for ice cream, would love to have long-term weather forecasts. Because it would be invaluable for them (if accurate), they may be willing to pay quite some money to meteorology departments to make a forecast of next summer's weather. Through pure crystal ball gazing, meteorology departments take in money that could be used for other (more useful) things.

To summarize mathematically the discussion above, one can say the following. Given the initial conditions

$$x_1, x_2, x_3, \ldots x_N$$

one can calculate the final condition via

$$\mathit{final\ result} = f(x_1, x_2, x_3, \ldots x_N)$$

If the initial conditions x_i have a margin of error, so will the final result. If the margin of error of the final result becomes arbitrarily small for small enough errors of the x_i, then the situation is nonchaotic.

If the margin of error (variation) of the final result stays “big” even though the margin of error (variation) of the initial conditions becomes arbitrarily small, then the situation is *chaotic*.

From this definition, it should be clear that chaos is by no means limited to science and math. Planning and forecasting in business is nothing but taking today’s and maybe yesterday’s data as initial conditions from which tomorrow’s data are calculated.

Especially mathematicians and physicists studied chaos intensively through the 1970s and 1980s. They tried to find out what makes a function chaotic and how to describe a chaotic situation. By and large, they found a proper theory for it. To get an impression of their results, please refer to appendix 8.5. One of the main areas of interest was to prove whether a certain function shows chaotic behavior or not. Detailed answers to this question may easily fill entire books. One main ingredient for chaotic behavior is easy to name: nonlinearity. Functions must show nonlinear terms (of a certain strength) in order to be candidates for chaotic behavior. Another area of interest is to find ways to deal with chaotic situations, such as turbulence, rather than only to describe them. There the progress is pretty limited, and research is still going on today.

Some conclusions from chaos have made it into the applied science world of engineering. For example, bearings in machines sometimes wear out only partly and at a few spots. That is a pity. Although 90% of the bearing is still okay, it must be change because 10% is damaged. Using a bearing “equally” would therefore extend its usage period by 10 times. This can be done by using a machine design wherein the forces on the bearing do not come from one typical direction, but chaotically determined directions. Because the initial conditions will always change slightly, the forces on the bearing will reach all points of the bearing, leading to an equally worn bearing. Another example is the Eurofighter military plane (still under development). Normally, a plane should fly in a nonchaotic regime. All forces come from a well-defined direction, and that makes flying easy for the pilot. In a turbulent situation, forces change rapidly and make flying "by hand" impossible. The Eurofighter is deliberately constructed to be always unstable (in turbulence). On the negative side, no human can fly this plane. One needs sophisticated computer software (a flight control system) to fly it. On the positive side, sudden changes in direction are possible. This makes the Eurofighter superior to all other fighter planes in existence today.

It is may be a psychological effect that humans tend to accept and admire such positive effects of chaos as a long-lasting bearing. They tend to ignore chaos in situations where there is no positive effect. It confuses their picture of the world that, for example, a long-term weather forecast is impossible. The psychology behind this is easy to understand, but ignoring the facts does not lead to progress. In my opinion, that is the very reason why chaos in business is mostly ignored. Good managers and businesspeople are optimists. They do not want anybody to destroy their tools of, for example, planning without offering a suitable substitute. Another example where people love to ignore the facts is in billiards. It is a nice game, and those who master it might even become television stars. Up to a certain point, it is definitely the skill of the billiard player that determines winning or losing. But that is only up to a certain point. Physicists have extensively studied the mechanics of a billiard ball. It is a quite simple system and shows wonderful chaotic effects. The main finding is that after a couple of collisions the path of the billiard ball is completely chaotic. So, three collisions may be fine. After, say, 10 collisions, though, the path is severely influenced by, for example, the gravitational field of the fellow player standing near to the table. Obviously, no billiard player can take such thing into account. Therefore, the outcome of multi-collisions is pure luck. (I regret that most billiard fans will hate me for this remark.)

6.5.2 Chaos in the business world

Planning and forecasting is arguably a key task of any manager, and a forecast in business is not fundamentally different from the weather forecast. The latter is severely limited by chaos, and it is only natural to expect the same for a business forecast. A very special business forecast is to predict a stock value. Today's or tomorrow's stock value for a particular company is proportional to its future earnings (at least it should be), but forecasting it is next to impossible. A rough share price forecast is possible, which is also the case for a long-term weather forecast. (For the next 100 years, I can predict that it will be warmer in Death Valley than in Oslo.) There are extremely persuasive indications that forecasting stock values is limited due to the existence of chaos. Still, there is no mathematical proof (e.g., via the Lyapunov exponent, cf. appendix 8.5) that chaos exists there. Such proof is impossible due to the fact that there are no exact formulas to calculate a future stock value. An experimental proof is also impossible, because a situation in the stock market cannot be repeated with slightly changed initial conditions.

But having (almost) no exact mathematical formulas in business does not mean chaos is not present. Even a million years ago weather forecasting was already chaotic even though math did not exist at all. Without rigorous formulas, it is just more complicated to identify a chaotic situation. But chaos is easy to spot in simple situations. As stated earlier, chaos comes typically into play if strong nonlinearities are present. Analogous to a strong nonlinearity in a mathematical formula in the business world is an "if…then" decision. Consider, for example, a project where you want to present your final results at an annual trade fair. Applying to participate in such a fair may have a deadline, and if you postmark your application just 1 second late you may have to wait another year for the next fair. This is a typical chaotic situation where a very small change in initial conditions (here a difference of 1 second) changes the outcome dramatically (here by 1 year).

Although the example just described is truly chaotic, it is too simple to cause any real problems in business. If the project's plan is much more complex, however, and it involves many if…then decisions, the ending date for the project may easily move about, even though only very tiny changes had been made. Needless to say, ordinary project management is a complete waste in a situation wherein one simply cannot predict the end date. A very rigorous but simple example is given at the end of this section.

Another candidate for chaotic situations in business is the example of long and complex supply chain networks. Because there is no standard supply chain network, it is impossible to make such statements as: "Chaos starts if x number of vendors are included in the network." Just as in big projects, the onset of chaos depends on the particular case. To probe whether chaos exists or not is, however, not so complicated as some might think. In project management or in supply chain management one normally has software that makes the calculations and predictions. Such software is analogous to a mathematical formula, except that it is in a black box. Finding numerical evidence for chaos in it is straightforward. Normally, one enters many initial data, such as delivery times or workloads, then the software produces a result for something like a finishing date or total cost. Instead of inserting single numbers for the initial conditions one should insert distributions. Typically, one may choose a Gaussian distribution for the initial conditions. Please note that *all* initial conditions must vary *independently*. All parameters such as production cost or storage capacity are considered elements of the initial condition. In doing so one can easily create over 1,000 independently varying initial conditions. Maybe one needs something bigger than an ordinary PC to perform the calculation in a reasonable time. One will end up with a final result showing some distribution too. (Instead of, e.g., a finishing date of October 31, 2007 one will have a finishing date between October 15 and November 15, 2007.) There are two possible outcomes:

- The result shows essentially the same distribution as did the initial conditions.
- Even for very small variations in the initial conditions, the result has a completely different distribution, and in the extreme case a random one.

In the first case, one has proven that no chaos is present. Besides being sure, such result is valuable for other reasons. For the width of the distribution of the initial conditions, one should take the typical margin of error in such numbers. (Please note that every number has a margin of error, cf. 6.1.2.) Then the width of the distribution of the final result is its typical margin of error. Quite often, one finds that this margin of error is too large to allow drawing any conclusion from the final result. As an example, let us suppose the total delivery time in an industry is between 20 and 30 days. In our own company, it is 26 days. A simulation of a completely new supply chain network gives a result for a new delivery time that is between 19 and 32 days. Obviously, such information is of no use whatsoever, although the system is not chaotic.

In the case of the second bullet point above, the distribution of the final result is changed substantially. This indicates chaotic behavior. In this case, any further use of the system is utter nonsense. Here one may be able to prove chaos exactly. If the variation of the initial conditions becomes arbitrarily small and the final result nevertheless shows a random distribution (sometimes known as “white noise”), then chaos is fully developed. It is an alternative but identical definition to the definition of chaos by the Lyapunov exponent being bigger than zero (cf. appendix 8.5).

I have just shown how to spot chaos in systems used in business. One additional important point is that if an IT system shows chaotic behavior there are two possible reasons for it:

- Reality is chaotic here.
- Only the underlying model is chaotic.

The first case is rather a hopeless one. It is a situation like the long-term weather forecast. In the second case, the reality is nonchaotic but the model used makes the reality appear chaotic. All models used in IT systems are more or less accurate descriptions of the reality, and, in this instance, it is possible to bring the model closer to reality in order to be nonchaotic. Although it is better to encounter the second case, because it at least allows the potential for a solution to be found, it can be next to impossible to distinguish between these two cases.

Example: Warehouse locations

And now I come to an example from the business world through which it is easy to see how chaos develops. It is the problem of warehouse location. There are two competing costs that determine warehouse locations. One is the transport cost. If it were the only cost, then there should be a warehouse (and production site) at every individual client. Transport cost would be zero in this case. However, the costs of warehouses are extremely high. They are minimized if a single, central warehouse is built. One may expect to find an optimal solution (minimum total cost) by having "some" warehouses at particular locations. Obviously, the result will depend on the cost data for transport and warehousing as well as the locations and sizes of the customers. Standard software is available to solve problems like these. In order to *see* how chaos develops here, I will not use such tools. I will create an admittedly oversimplified situation. Then one can solve the problem easily and see how chaos comes into play.

In my model, there are just two customers: C_1 and C_2. Their distance is d. C_1 and C_2 consume goods at the rates c_1 and c_2, respectively. There are only two possible solutions imaginable: two warehouses or one warehouse. In the case of two warehouses, each warehouse is onsite at one customer and this leads to zero transport cost. In the case of one warehouse, its location should be at the bigger customer. This minimizes transport costs (as only the smaller amount of goods must be transported). The cost of a warehouse is independent of its location. Let us assume that C_1 is the bigger customer ($c_1 > c_2$). Furthermore, the fixed cost of a warehouse would be f_W. Its variable storage cost is proportional to the consumption rates (c_1 or c_2 or both) with a specific storage cost rate α. The transport costs are proportional to the amount delivered and distance with a specific transport cost rate of β. The total costs for arrangements with one (C_{one}) or two (C_{two}) warehouses are

$$C_{one} = f_W + \alpha \cdot (c_1 + c_2) + \beta \cdot d \cdot c_2$$

$$C_{two} = 2 \cdot f_W + \alpha \cdot (c_1 + c_2)$$

If C_2 were the bigger customer ($c_1 < c_2$), then the result would read as

$$C_{one} = f_W + \alpha \cdot (c_1 + c_2) + \beta \cdot d \cdot c_1$$

$$C_{two} = 2 \cdot f_W + \alpha \cdot (c_1 + c_2)$$

The decision whether there should be one or two warehouses is based upon minimum cost. In the first case ($c_1 > c_2$), we have

$c_2 > \frac{f_W}{\beta \cdot d}$ for two warehouses (one at each customer)

$c_2 < \frac{f_W}{\beta \cdot d}$ for one warehouse at C_1

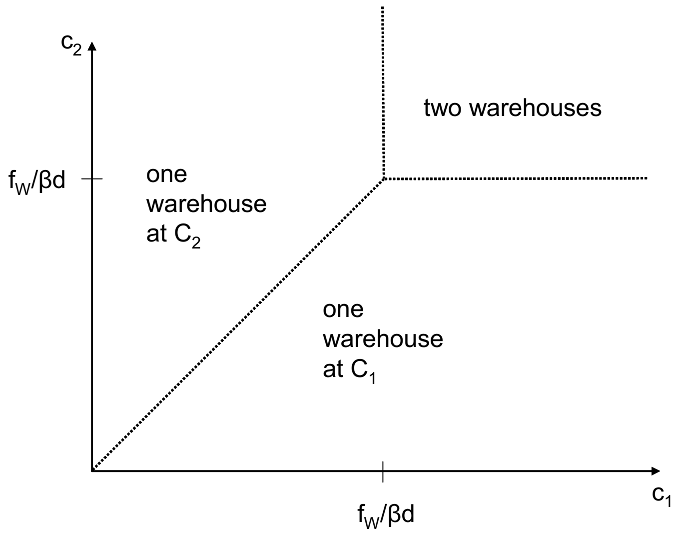
In the second case ($c_1 < c_2$) we have

$c_1 > \frac{f_W}{\beta \cdot d}$ for two warehouses (one at each customer)

$$c_1 < \frac{f_W}{\beta \cdot d} \qquad \text{for one warehouse at } C_2$$

The result can be displayed graphically as in Fig. 6-12. For very big consumption rates c_1 and c_2, one should have two warehouses. For smaller consumption rates, there should be one warehouse at C_1 or C_2. As displayed in Fig. 6-12, the result depends upon the customers' consumption rates c_1 and c_2. However, if the consumption rates have values arbitrarily near to the dotted lines of Fig. 6-12 an arbitrarily small change in consumption may produce a big change (e.g., the move of a warehouse from its being at C_1 to C_2). So, the dotted lines denote the chaotic regime in this setup.

Fig. 6-12: *Regimes of one or two warehouses depending upon c_1 and c_2*



Of course, more realistic situations involving several clients can be easily constructed. The method of their solving will be identical. In most cases, however, only a numerical solution is possible. One may expect there to exist certain complicated areas of chaotic behavior rather than just dotted lines. Further research is necessary here. It will be an ideal playground for a PhD student.

Before closing, I want to say a few words about the software tools available for solving this class of problems. They can of course be used to spot chaos here, and one should scrutinize whether they show chaotic behavior or not. Most of them do not, however, calculate the number of warehouses. One must first enter the number of warehouses, and then the software calculates their locations. In doing so, one avoids the chaotic situation stated above and one will probably find no chaos at all.

6.5.3 Dealing with chaos

Thus far, I have explained what chaos means, where one might expect it to be, and how to prove it. Because chaos makes things unpredictable, one should try to avoid it. This is definitely the best advice on how to "handle" chaos. Nevertheless, it is not always possible to stay out of chaotic situations. In what follows I will tell about how scientists try to handle chaotic situations. Then I will show how nature deals with chaos in a very elegant way. From this, I will draw conclusions for the business world.

As I remarked already, scientists improved upon the theory of chaos a lot during the 1970s and 1980s. They made great progress in understanding chaos itself and the mathematics behind it. Up to now, however, there is little progress in dealing with chaotic situations themselves. To see what I mean, consider the smooth flow of a river. Such flow is easy to understand and can be described with quantities like the flow velocity. However there is a certain point at which such smooth (nonchaotic) flow changes to being turbulent or chaotic. This typically occurs when the flow velocity reaches a certain point. A waterfall might be the best example. In a smoothly flowing river, it is straightforward to calculate (predict) the flow velocity at any point. In a waterfall, there exists a flow velocity at any given point, too. However, to calculate it involves chaos. Therefore, the flow velocity at a particular place and time depends greatly upon whether somebody had thrown some pebbles into the water a minute earlier. For practical purposes, such flows appear to be unpredictable[5]. It is definitely the wrong approach to use bigger and bigger computers in order to take into account each and every little disturbance. First, such a computer must be very big. Even today's supercomputers are not sufficient for it. Second, the result would be completely useless. It would have the form that billions of initial conditions imply billions of flow velocities a second later. Obviously, such a flood of information would be as useful as no information at all. A much more promising approach is to consider the frequencies of change in the flow velocities instead of the velocities themselves. Such frequencies are known as the "Fourier transformed" velocities. There is even a simple formula to calculate the Fourier transformed of a given velocity field. Even a backward transformation is simple. Therefore, understanding the Fourier transformed world is as useful as understanding the "real" world. Unfortunately, the Fourier transformed of a turbulent flow looks as dreadful as the original function for the velocity. Scientists tried hard to get some simple information out of it, and they used very sophisticated tools. Nevertheless, the progress is pretty limited up to now. Quite similar approaches were also used in order to understand the chaotic motion of the stock market. The result is similarly disappointing.

So much for the direct approach of dealing with chaos. I personally think that the approach discussed above, and others similar to it (e.g., involving advanced statistical methods) will not lead to progress any time soon. Indeed, my gut feeling is that they will never make progress. There is, however, one perfect approach for dealing with

[5] Please note that the average total flow hardly changes. The dramatic changes occur on a detailed level only.

chaos. In some sense, it is not even man-made. Nature is its architect. The only drawback is that it sometimes works fine but not under all circumstances. To see what I mean, consider a glass of water standing on a table. It is definitely not chaotic. There is no flow at all. Slight stirring will create a flow that is still far from being chaotic. However, if one looks at the individual water molecules in the glass, he or she will see a very chaotic motion in both cases. To describe this – not to mention predicting it – is impossible. In contrast, the smooth flow of water in a glass is simple to describe – and is easily predictable. We have a situation, then, where there is chaos on a microscopic scale but a smooth flow on the macroscopic scale. The way of describing this macroscopic flow is known as "hydrodynamics." Please note that hydrodynamics is not limited to water or fluids. A piece of wood, for example, has its hydrodynamic. Hydrodynamics is a macroscopic description of something. Deriving the formulas for such description does not involve a microscopic view. Though a hydrodynamic flow velocity is equal to the average velocity of the underlying molecules, it is not derived by considering the individual molecules. (Otherwise, chaos would make it impossible to find the hydrodynamics of, for example, water.) In order to obtain the hydrodynamic equations for a particular system, a microscopic knowledge is not required. Therefore, the hydrodynamic equations for, say, water and honey are almost identical. In contrast, the respective molecules of water and honey are extremely different. To further complicate matters, consider the cases of water and ice (frozen water). The molecules of these two systems are identical, but the structures of their hydrodynamic equations are completely different.

Considering this, the hydrodynamic approach may look like a panacea for tackling the stock market problem. The change of a stock price at a particular time may be unpredictable, but a hydrodynamic approach could predict the average value in, say, a month. As we learned from the above, in order to find the corresponding hydrodynamic equations one does not need to understand the mechanism of why and how a particular stock value changes. As I am publishing these words in a book, there must be something preventing me from being the first to become a billionaire on the basis of this insight. This something is easy to state: A hydrodynamic approach is not always possible. In what follows, I will give a simple (although not completely rigorous) explanation of what makes a hydrodynamic approach possible sometimes and impossible at other times. The result will help to show whether and where a hydrodynamic approach might lead to useful descriptions in business situations that are chaotic.

There are three prerequisites to make a hydrodynamic description possible:

- One must have a complete set of macroscopic variables.
- There must be a clear-cut difference between the microscopic and macroscopic (hydrodynamic) scales.
- Interactions may go from the macroscopic to the microscopic scale but not vice versa.

The three points need some explanation. In order to describe something one must have variables. The set of variables must be complete. In the case of water, these variables are easy to name: three components of the momentum vector, the mass, and the energy. “Complete” means that two flows of water with identical values in these five variables are undistinguishable (on the macroscopic scale). In the case of, say, a stock it is already trickier. Its value alone cannot be sufficient. From time to time, a stock might show the same price as it had previously. That does not mean, however, that everything else is identical. Such other quantities as, for example, profit per share are most likely also necessary. (In some sense, the price of a stock is the least reasonable quantity because it is no conserved quantity, cf. 6.5.4.) Although I do not have an answer ready as to what are the macroscopic variables for a stock, I see no fundamental obstacle here.

The second prerequisite relates to the scales. In some sense, this condition defines the range of validity of a hydrodynamic approach. In the case of the flow of water, one hydrodynamic equation is called the Navier Stokes equation. From a mathematical point of view, it is a differential equation.[6] Its solution describes the flow of water and other fluids. Mathematics does not know a smallest number. Therefore, formally the solution of the Navier Stokes equation yields solutions of an arbitrarily short length or time scale (e.g., the motion of a droplet of water measuring a trillionth of a millimeter within a trillionth of a second.) If this time or length scale reaches the microscopic time and length scale, however, the Navier Stokes equation is no longer valid. In the case of the stock market, the microscopic (time) scale is the time it takes for a new stock value to be established (perhaps every couple of minutes). So, the macroscopic time scale would be a day or a week. While that is a certain limitation, predicting an average stock value within a week would be already a big advantage.

The third prerequisite is normally the most difficult to achieve. Interaction between the macroscopic and microscopic scales means the following. If somebody stirs a glass of water, then a circular flow is created. Without stirring, the flow will stop after a while. (This phenomenon is called dissipation or damping.) The energy is conserved. So the macroscopic flow energy dissipates into the motion of the individual molecules. Their motion is severely affected by the macroscopic flow, but it is never the other way around. From the law of conservation of energy (and other conservation laws from physics), it is permitted that all molecules might flow in a certain direction, leading to a spontaneous macroscopic flow. In some sense, however, such a phenomenon is very unlikely. So unlikely is it, in fact, that the universe is far too young for it yet to have happened even once. The direction of interaction can be described in another way. Somebody makes a movie showing the macroscopic variables (e.g., flow velocity of water,) only. If it is possible to distinguish between a movie running forward or backward, then the third prerequisite is fulfilled. A movie

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[6] It takes the form $\partial t\, \mathbf{v} + (\mathbf{v}\, \nabla)\mathbf{v} = -1/\rho \text{ grad } p + \eta/\rho\, \Delta\, \mathbf{v}$

running forward will show a flow of water that gradually vanishes (while the temperature of the water increases). If the movie shows a glass of water with initially no flow but a gradually increasing flow (and lessening temperature), then one can be sure that such movie is running backward. However, if somebody shows a movie (admittedly quite boring) noting only the price of a particular stock, nobody can tell whether the movie is running forward or backward. It is exactly for this reason that the third prerequisite does not hold for the stock market. Therefore, the chaotic motion of a stock market cannot be described by a standard hydrodynamic approach.

Up to now, I have explained whether a hydrodynamic description is possible or not for a particular system. How actually to find the hydrodynamic equation is a completely different question. I will briefly comment on it towards the end of this section, but I must stress that the main discovery is the existence or nonexistence of a hydrodynamic (macroscopic) description. Finding rigorous hydrodynamic equations for business situations is far more difficult than in systems like water. If a macroscopic description exists, it makes sense to try and find a useful approach. Trial and error may determine which way is promising and which is not. However, if the hydrodynamic description is not possible, a macroscopic approach does not make sense. In the case of the stock market, for example, a hydrodynamic description does not *exist*. Therefore, it does not make sense to look for one. This should be important news for all people who are still trying. For reasons that are fundamental, they will not succeed (even if they try harder and harder!).

Example: Chaotic project

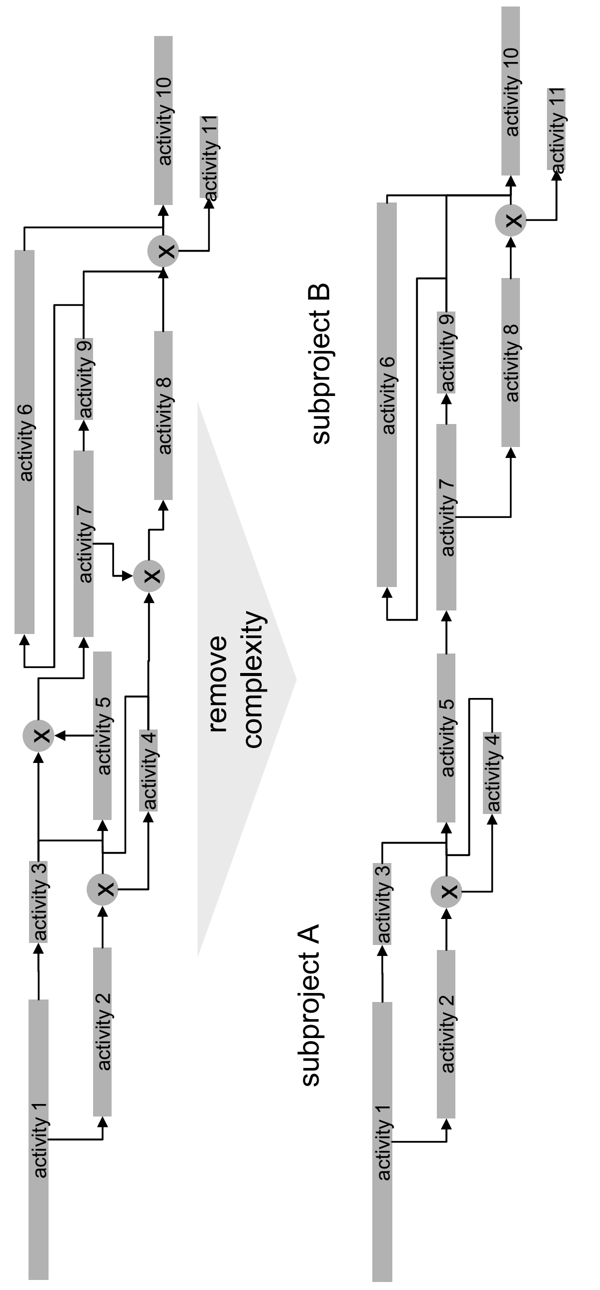
As an example, consider a chaotic project plan. This is a project plan where variables such as the finishing date move about chaotically although the initial conditions (e.g., workloads for the particular tasks) are changing only slightly. Such project plan can be constructed easily, and especially if many if…then decision points are included. For a project manager it is impossible to handle the situation. He or she most likely will try to keep the finishing date as early as possible. It is normally done by shifting capacity from one area (with enough human resources) to another (with a shortage of human resources). But even for slight changes he or she will create a completely different picture. The end date may shift in the desired direction or in the opposite one. The question is will there be a hydrodynamic approach making project management possible? Prerequisites one (macroscopic variables) and two (different scales) may be fulfilled, but prerequisite three (direction of interaction) will not be fulfilled. This is clear if one imagines a movie say showing the scheduled end date and, especially, its variation over time. Nobody will be able to tell whether such a movie is running backward. Therefore, a macroscopic description is impossible, and any attempts to manage such a project in the classical way are a pure waste. Other than simply to not manage at all and waiting for the outcome, two approaches are possible here.

- Consider only variables that allow for hydrodynamics.
- Change the project plan by removing complexity.

The first approach means taking only those variables as a complete set that meet the third prerequisite. Consider, for example, the workload performed as a function of time as the only variable. This is an ever-increasing variable. If a movie is showing this variable, it is clear whether it runs backward or forward. The drawback of this approach is that to consider the workload only is far from being sufficient for most purposes. Therefore, this approach is of very limited use here.

The second bullet point above is much more promising. This means removing chaos. The origin of chaos was in the if…then decisions. These especially add to complexity when they influence very different areas in the project plan, as they produce unforeseeable (chaotic) changes. By removing enough of these long-reaching connections,

***Fig. 6-13:** Removing complexity from a project*



chaos will eventually be eliminated. Please note, however, that it will change the project plan. The project plan will no longer correspond to reality exactly, but, if done skillfully, the plan will still be useful. It will lead to a project plan that will not finish the project in the shortest time and with the lowest workload possible, but it will make the project manageable. The simplest way of achieving this is to cut the big project into smaller ones. The smaller projects should be so small and simple that they are (considered individually) not chaotic any longer. Then these projects are supposed to run in a sequence rather than partly in parallel. Only the start and finish are connected. Then the entire project is no longer chaotic, so long as the subprojects are not chaotic. The overall completion date, then, is a linear function (sum) of all the durations of the subprojects. Of course, this new and simplified project plan will not correspond to the optimum normally defined as the shortest duration and lowest workload. For a graphical visualization of the procedure, please see Fig. 6-13. This displays a Gantt chart for a complex project and for its simplified version.

The way just described for removing complexity and therefore avoiding chaos is by no means limited to project management. Project organization takes the same form as any other organization (which is the reason I do not have a chapter on project organization in this book). Organizing any process (e.g., a supply chain) may lead to chaotic outcomes. The way of removing complexity as described above is called decentralization in the language of organization (cf. end of 5.2.1). As stated already, decentralization removes complexity and it avoids chaos. This is especially true for long and complex supply chain networks. They are archetypal examples of where to find chaos. Unfortunately, they are now quite in fashion. Initiatives (e.g., the SCOR model[7]) that mostly are sponsored by software producers promote these complex supply chain structures. To my knowledge, nobody has looked for chaos in such complex supply chains up to now. More than likely, though, it is there. Moreover, nobody has even

[7] Supply Chain Operations Reference model

been able to show me that he or she has saved any costs by introducing a complex supply chain network. (Please note that shifting cost from one partner to the other does not constitute cost saving.)

This section has dealt with the hydrodynamic approach. It is a macroscopic approach that is fine to use even if the underlying microscopic world is chaotic, but its use is not always possible. Please note that there is no proof that the hydrodynamic approach is the only possible approach to a macroscopic description. It would be especially nice to have a modified hydrodynamic approach that does not require the third prerequisite (direction of interaction). Just skipping the third prerequisite leads to "something" which one might call a generalized hydrodynamics. However, it is of no use whatsoever. My colleagues and I intensively sought a (useful) generalized version of hydrodynamics at the California Institute of Technology more than 15 years ago. The immediate purpose was to find a reasonable description of turbulence in fluids. We found nothing reasonable. While this is no proof of the generalized version's nonexistence, it seems to me rather unlikely that such a thing will be found.

Now then, on to my promised description of how to find hydrodynamic equations. As stated already, to prove or disprove the existence of a hydrodynamic description is the major point, and especially for business situations. To actually obtain rigorous equations might rarely be possible or useful. Be that it as it may, to derive such equations, one would proceed as follows: First, one writes down the most general version. Then one looks for those terms that are forbidden by symmetry considerations or other prerequisites. To see what I mean, consider the value (v) of a company. Now, let us suppose that this is a function only of revenue (r) and number of employees (n). (For a management consultancy, this would be about the right level of complexity.) The value function v(r,n) takes the most general form[8]

[8] This is a Taylor expansion. Critics might say that it may only be used for analytic functions. However this, after all, is a hydrodynamic description. In fact, it is only valid up to a certain scale and, also up to a certain scale, even nonanalytic functions can be written in a Taylor series.

$$v(r,n) = v_0 + a_{10} \cdot r + a_{01} \cdot n + a_{11} \cdot r \cdot n + a_{20} \cdot r^2 + a_{02} \cdot n^2 + \ldots$$

The a_{ij} are general parameters. For n = 0 (no employees) or r = 0 (no revenue), one has no company. Its value must be zero. Therefore, quite a few terms in the formula above can be excluded. ($v_0 = a_{10} = a_{01} = a_{20} = a_{02} = \ldots = 0$) The most general formula may look like the following:

$$v(r,n) = a_{11} \cdot r \cdot n + a_{21} \cdot r^2 \cdot n + a_{12} \cdot r \cdot n^2 + a_{22} \cdot r^2 \cdot n^2 + \ldots$$

The next step involves symmetry considerations. While it sounds odd, revenue and number of employees could be negative, at least if only costs are considered. A negative employee would mean someone who pays for working. Negative revenue means paying your customer for taking the goods. Because the formula is a general one, it must lead to a negative value if r and n change signs simultaneously. Therefore, only those terms are allowed for which the sums of the powers of r and v are even numbers. Therefore the most general form is:

$$v(r,n) = a_{11} \cdot r \cdot n + a_{22} \cdot r^2 \cdot n^2 + \ldots$$

One may skip higher powers because the approach is only good up to a certain scale. If somebody believes that this formula looks strange and can be disproved by a real life example, he or she may be correct. However, this will only negate the initial assumption that the value v is only a function of revenue r and number of employees n.

6.5.4 Conserved quantities

This topic is not connected to chaos and is only loosely connected to hydrodynamics. (Although hydrodynamics uses conservation laws, it is not limited to conserved quantities.) Again, I will start with the meaning of the term "conserved quantity" as defined in science. Probably everybody is familiar with the principle of physics which states that energy is neither created nor destroyed (i.e., that it is conserved). This does not mean that it stays constant everywhere. Rather, if energy is reduced in some place it increases in another. Using energy as a variable to describe something is useful twofold. First, one has already a certain form with which to describe something. The change in energy E inside a system must be identical to the difference in incoming and outgoing energy current Q. Translated into mathematics, this takes the form of a partial differential equation.[9] Such equations are very helpful in science for formulating hydrodynamic equations. Second, using conserved quantities will avoid a spontaneous change in this quantity. The energy, for example, cannot be changed spontaneously. Otherwise, an infinite energy current would be required. Nonconserved quantities may change without notice, and therefore they are rarely suitable for describing anything. Something that may change even though *everything* else remains constant is normally regarded as unrelated to the system under consideration. It is therefore unsuited to describing that system. This has a very fundamental implication in business, management, and economics.

In the business world, too, one has conserved and nonconserved quantities. Conserved means here that they cannot change without a change in something else. Revenue is an excellent example of a conserved quantity. If the revenue increases, somebody else's cost must also increase. The same is true for most cost data. If labor costs increase, then salaries must too. Because business is mostly occupied with numbers expressed in currency units, one might conclude that in business one deals *only* with conserved quantities. But this is not the case. The (market) value of something is not a conserved quantity, for example. It may change without notice. This is exactly the problem with the stock market. A crash may halve the value of 1,000 companies

[9] It takes the form: $\mathring{E} + \nabla \cdot \vec{Q} = 0$

within an hour, even though observing the life inside these companies during this hour would find almost no change. Therefore, the value of any particular stock is *completely* unsuited to describe how the company is running. The same is true for almost any value that is assigned to something. The word “almost” has to do with the fact that, as suggested by Karl Marx quite some time ago, one can distinguish between exchange (or market) value and intrinsic value. The exchange value is a nonconserved quantity. The stock may take on any exchange value in an arbitrarily short period of time. By contrast, the intrinsic value reflects some underlying element or elements. Only if the underlying element changes will this value change. Therefore, it is a conserved quantity. Taking the discounted cash flow of a company as proportional to its value, makes this value intrinsic and a conserved quantity. Obviously, at least during a stock market crash, nobody honestly has thought that the expected cash flow of, for example, 1,000 companies would halve. Collector’s items are archetypal examples of goods that may have high exchange values but intrinsic values close to zero. When the internet bubble burst, some people explained it by saying that “technology stocks had become collector’s items.”

The problem with value is even more complicated than indicated above. As soon as one exchanges a good for money one has real money in the pocket, which is a conserved quantity (at least if one neglects inflation or deflation). So, something with no intrinsic value will suddenly create intrinsic value for a person.[10] Consider now the accounting for changes in the values of assets on a balance sheet. Assets are a company’s economic resources that are expected to contribute to revenues (and, potentially, profits) in future time periods. How should one account for these in order to reflect the real financial situation? If these assets are things exchanged (bought and sold) very frequently, then it is reasonable to regard their exchange values to be the same as their intrinsic values. The stocks owned by an investment bank fall into this category. If the assets are but rarely exchanged,

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[10] If a good is exchanged for another good, one may exchange one collector’s item for another. This may be the case if an acquisition is paid for by exchanging stocks.

however, then the intrinsic value is the only reasonable quantity. If the exchange frequency of the assets does not fit into either category, then I have no good answer for how to deal with the value of assets. Please note the dramatic consequence of this. A good portion of the profit and loss of most major companies is not realistically accounted for, and this means that valuation-related accounting principles generally are in need of a complete overhaul. Please note that the problem here has nothing to do with the general issues of valuation for assets and liabilities being an unresolved and challenging accounting issue. The problem here is much more fundamental. Intrinsic (conserved) values are added to exchange (nonconserved) values. Such addition has the same meaning as adding six pencils to five light bulbs leading to 11 penculbs.

So my urgent advice is to use only conserved quantities for making judgments. And the value is especially tricky. In preparing balance sheets and profit and loss statements, one should distinguish between two things. First is the accounting required by the legislation of a particular country.[11] One has no choice other than to do it in accordance with the law. But whatever comes out from this official consideration should not be taken at face value. It is absolutely necessary to perform a different accounting in order to control the real financial status of a business. Unfortunately, this is rarely done. Many people even believe that it is not necessary. At the end of the 1990s, I had personal contact with CEOs of newly established technology companies. They made (at least temporarily) real money, but they could not explain in simple words where it came from. Eventually, it became apparent that the source was entirely in buying and selling stocks or performing initial public offerings (an exchange of collector's items). The exact mechanism was hard to pin down, especially if a complicated network of companies was behind it. Some of these CEOs had advanced business degrees, and they most especially got fooled.

[11] Depending on the legislation neither the exchange nor the intrinsic value may be used for assets. A value defined as original price minus depreciation is quite common. But it has hardly any meaning for a big class of assets.

They had learnt accounting rules and used them eagerly. The only mistake was to take them at face value. People without formal business educations had an advantage, because they only believed in profit if the underlying operation produced a positive cash flow. They took the very good advice to *understand* what is going on rather then merely to make abstract calculations. So, my advice to every CFO is to understand what is going on. According to the late Nobel laureate in physics Richard Feynman, understanding something means to be able to explain it to freshman. If this holds for theoretical physics, then it also should be true for accounting.

7 Operations management

This chapter offers some tools for operations management. They are not so basic as are those in the rest of this book, but they are useful and maybe sometimes indispensable. There are many more of them, and they represent the subjects of many books on management. The choices as to what is presented here were based upon my personal experience. In particular, I will shed some light on areas that are rarely considered but are nevertheless quite important. Therefore, this chapter is mostly complementary to other books about the same tools.

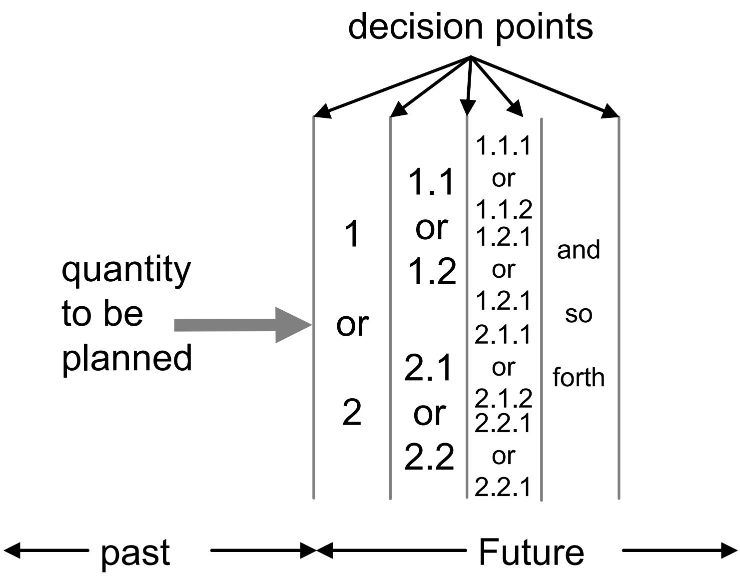
In 7.1, I will scrutinize the planning process. The essential result will be to recognize that the uncertainty in planning grows exponentially in time. In 7.2, I will comment on benchmarking. The emphasis will be on what benchmarking can do and what it cannot. Doing something several times normally improves efficiency, and this can be expressed as a learning curve. Deriving and using learning curves will be the content of 7.3. I will close with some remarks on what I call "soft skills" (7.4), which are about the *ways* to make things happen.

7.1 Plan and forecast the business

Planning and forecasting is the essential task of almost every manager. To reach a goal requires having one. That goal must follow from a proper plan and forecast. Controlling (cf. chapter 4) and balanced scorecard (cf. chapter 3) are parts of the planning process. Standard approaches for an entire planning process may be found in other textbooks. Here I will stress the accuracy of a plan or forecast. It is possible to find the exact form for how an error grows over time in a forecast. Comparing this with measured accuracies from the past plan can predict whether a planning period of, say, five years makes sense or not. One immediate application is to probe the validity of a business plan that normally covers a period of several years.

It is obvious that a short-term plan is always more accurate than is a long-term one. This is completely analogous to the weather forecast (cf. 6.5). But exactly how the uncertainty will grow is not so obvious. Fig. 7-1 shows a growth model for uncertainty. As time passes, decisions must be taken whether to go this or that way. The vertical

Fig. 7-1: *Growth model for uncertainty u*



lines in Fig. 7-1 display such decision points. At each of these points, a quantity can go one of several ways. For simplicity's sake, just two choices are displayed in Fig. 7-1. In reality, this can be any number and it will change randomly. At the first decision point, the ways "1" and "2" are possible. At the next point, it is already "1.1," "1.2," "2.1" or "2.2." The number of possible ways is proportional to the uncertainty

u. As one sees from Fig. 7-1, uncertainty grows rapidly. To find out exactly how, one observes from Fig. 7-1 that the growth rate in uncertainty at each point is proportional to the number of possibilities already existing. Translated into mathematics, it means:

$$\Delta u \propto u + u_0$$

The u_0 is necessary for the uncertainty to develop. It is the "starting strength." In the continuous limit, one can translate this into a differential quotient:

$$\frac{du}{dt} = \frac{1}{\tau}(u + u_0)$$

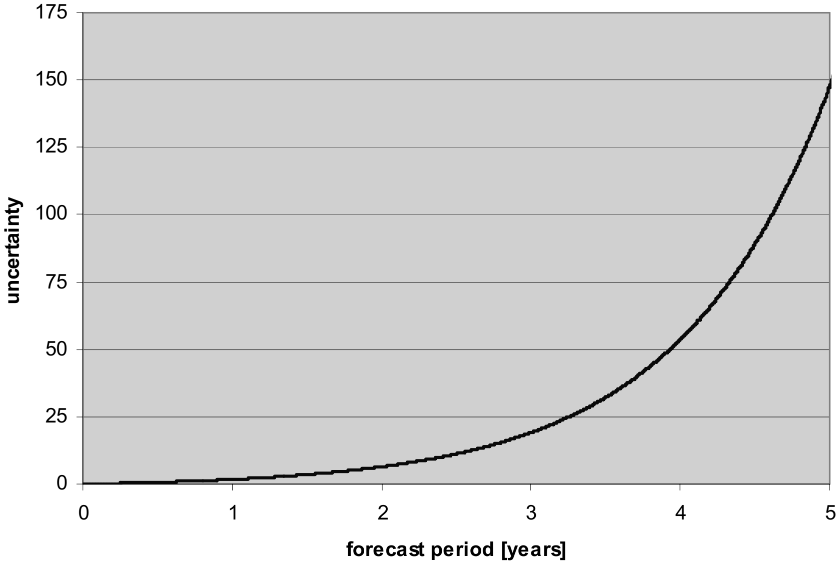
This is a very simple differential equation. τ is a constant with the dimension time. With the initial condition u(t=0) = 0, its solution is an exponential function of the form

$$u = u_0 \cdot (e^{t/\tau} - 1)$$

Depending upon the constants, the uncertainty is growing as indicated in Fig. 7-2. At one year, for example, the uncertainty is still very small (1.72 here). After five years, it already measures 147. From one to five years it has grown by a factor of about 85. Please note that it is not possible to calculate an uncertainty with this formula. The exact uncertainty of planning depends on how skillfully it is performed and how fast the environment will change. Here, only the development is calculated. Besides showing that a typical five-year plan is probably useless, it can be used to calculate planning values by comparison with former periods. An interesting example can be found further below.

The constants in the formula are not just fit parameters. They have some meaning. u_0 is the strength of the uncertainty. It measures how skillfully a planning has been performed. A 10% smaller u_0 means 10% better planning. In order to better grasp this, see the example about quality of planning further below. The constant τ is the time scale. In terms of the model of Fig. 7-1, it is the time span during which on average e (=2.71828…) different ways are taken. It is the typical period of change. Quite a few businesses have a typical periodicity of one

Fig. 7-2: *Exponential growth of uncertainty*



year. (It is the time span during which everything takes place once.) For such businesses, τ is typically around one year. Others, such as producers of nuclear power stations, run on a much longer time scale. In their cases, one order may be filled over several years. Typically, their τs are much longer than one year. That is why five-year planning works well in such companies even as it fails completely in other industries. A big τ results in a small growth in uncertainty while a small one produces a big growth in uncertainty. As a rule of thumb, I would state that a planning period of one to two τs makes sense.

As another example, let us look at the forecasts in e-business. Like most marketing-driven forecasts, they are too optimistic. But more important is that they are very inaccurate. Quite often, they are inaccurate by a factor of two, three or four – even though they are made for just two or three years. The explanation for this is quite simple. Technology and many other things change very rapidly in the e-business world. The time scale is at most a couple of months. Therefore, a two-year forecast in e-business is comparable to about a 30-year forecast in the industry building (big) power stations.

Example: Reasonable planning period

Within some business, people are considering to introduce a five-year planning period (sometimes called strategic planning). Is this reasonable? Most probably, several such periods will be needed in order to figure out whether it is justified or not, but the way to estimate it beforehand runs as follows. Let us suppose the uncertainties of previous planning periods are known. They are:

Period of length p_1 (e.g., 3 months) had an uncertainty of u_1 (e.g., 1%)
Period of length p_2 (e.g., 1 year) had an uncertainty of u_2 (e.g., 5%)

Such data are normally available or easy to obtain. If somebody plans revenues of €50 million over the next month but these actually reach €54 million, then the accuracy was 8%. From such data, the accuracy for any period of time can be estimated. One just has to insert the values into the formula for uncertainties above:

$$u_1 = u_0 \cdot (e^{p_1/\tau} - 1) \qquad u_2 = u_0 \cdot (e^{p_2/\tau} - 1)$$

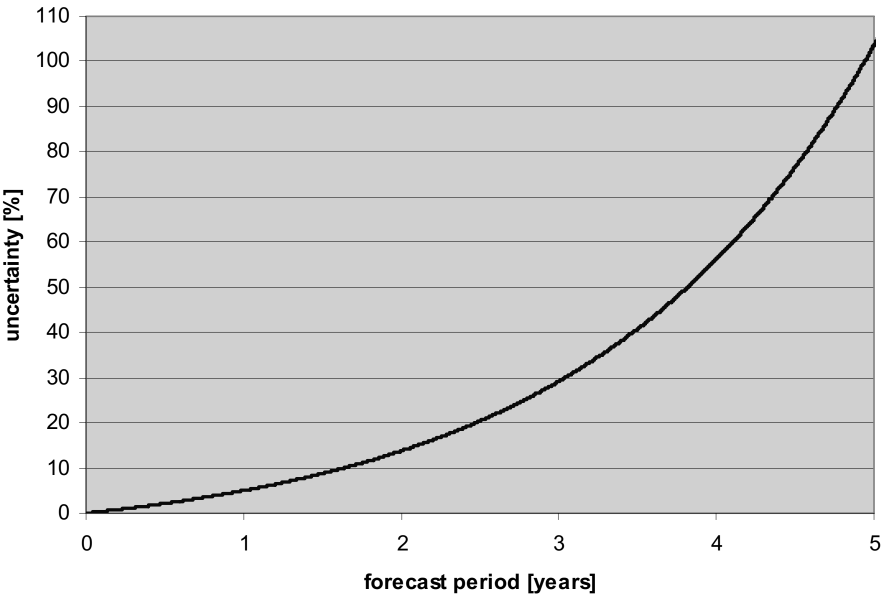
These are two equations containing two unknown variables u_0 and τ. Solving the equations leads to the values of the unknown variables. In general, such equations are so-called transcendental equations. They have no analytic solution. Their solution must be found numerically.

For some help in doing this, please refer to appendix 8.6. Taking the values from the example above (u_1 = 1%, u_2 = 5%, p_1 = 3 months, and p_2 = 1 year) a numerical solution yields u_0 = 6.63% and τ = 649 days. With it one can write for the uncertainty in planning

$$u = 6.63\% \cdot (e^{t/649\,days} - 1)$$

With this formula the uncertainty in planning can be calculated for any period of time. Of course inserting e.g. t = 1 year = 365 days leads to u = 5%. The result for the uncertainty is displayed graphically in Fig. 7-3.

Fig. 7-3: *Uncertainty for u_1 = 1%, u_2 = 5%, p_1 = 3 months, p_2 = 1 year*



One sees that a two-year planning period leads to an uncertainty of 13.8%, which is still reasonable. Even a three-year planning period leading to an uncertainty of 29.2% may be okay. However, a five-year planning period is definitely over the edge. It would show an uncertainty of 104%. It might be that not every five-year planning will look that bad. Everyone has to insert the values of his or her business in order to find it out. From my own experience, I know that most five-year plans are about as inaccurate as the example above.

Example: Quality of planning

Another use of the accuracy of planning is to judge about the quality of planning. As stated above, planning is a key skill for a manager. However, its quality is rarely controlled. In many cases, the boss honors a plan if he *likes* what is displayed there. Of course, this has nothing to do with the quality of the planning. Quite often, people control whether the goals from the planning are reached. This is necessary, but again it has nothing to do with the quality of the planning. Almost nobody can state a measure for the quality of a plan. It is not the overall accuracy. A plan showing an uncertainty of say 10% is not necessarily worse than a plan showing an uncertainty of 5%. First, different planning periods might have been taken (e.g., 3 months and 12 months). Second, the τ in one plan may be different from the τ in the second. This dramatically impacts the uncertainty. However, the accuracy also depends on the environment (e.g., how fast market conditions are changing). Therefore, the planner must be judged by how big his or her u_0 is. It determines the quality of planning.

Fig. 7-4: *Planning from 2003 to 2006 and its uncertainties*

year	1st plan	u_1	2nd plan	u_2
2003	three-month plan, p_1 = 3 months	1%	annual plan, p_2 = 12 months	20%
2004	six-month plan, p_1 = 6 months	4%	annual plan, p_2 = 12 months	10%
2005	three-month plan, p_1 = 3 months	2%	six-months, p_2 = 12 months	15%
2006	three-month plan, p_1 = 3 months	2%	annual plan, p_2 = 12 months	20%

In order to see how this works, consider the following example. In the table of Fig. 7-4, one sees the different years and the plans that had been made. After each period ended, the total uncertainty of each plan was easily determined. In order to see which year had the most skillful planning, one must determine the u_0 in every year. It is the same procedure as in the previous example. With the help of appendix 8.6 and especially Fig. 8-7 one can easily find the values for u_0 (and τ). Doing so is left as an exercise to the reader. The result is summarized in Fig. 7-5. The most skillful planning was performed in 2003. u_0 was

Fig. 7-5: *Measures of quality (u_0) for plans of Fig. 7-4*

year	p_1	u_1	p_2	u_2	u_0 [%]	τ [days]
2003	3 months	1%	12 months	20%	0.791	112
2004	6 months	4%	12 months	10%	8.00	450
2005	3 months	2%	12 months	15%	4.54	250
2006	3 months	2%	12 months	20%	3.03	180

just 0.791% in that year, although the uncertainty of its annual planning was 20% and that was one of the two worst. The least skillful planning took place in 2004. There u_0 was 8.00%, although its annual planning was most accurate with an uncertainty of only 10%. The result is surprising at first glance only. Looking at the values for τ explains the situation. In 2004, the period of change τ was 450 days. Due to the environmental conditions, the uncertainty grew very slowly. Holding uncertainty to 10% after a year was therefore easy. In contrast, 2003 had a period of change of only τ = 112 days. There the world changed much faster. Achieving an uncertainty of only 20% after a year indicates extremely skillful planning.

Please note that the numbers from Fig. 7-4 are by no means typical. On the contrary, they are very unlikely in reality. I have chosen them in order to emphasize the differences. Quite generally speaking, if the value for τ changes from year to year as rapidly as above something must be wrong. The change in the market conditions and other environmental factors is generally assumed to be pretty slow. One possible explanation for the numbers above would be that a different quantity was planned in each year (e.g., revenue in 2003 and number of new customers in 2004). Planning one thing is easier than planning another, and that is not necessarily related to the skill of the planner.

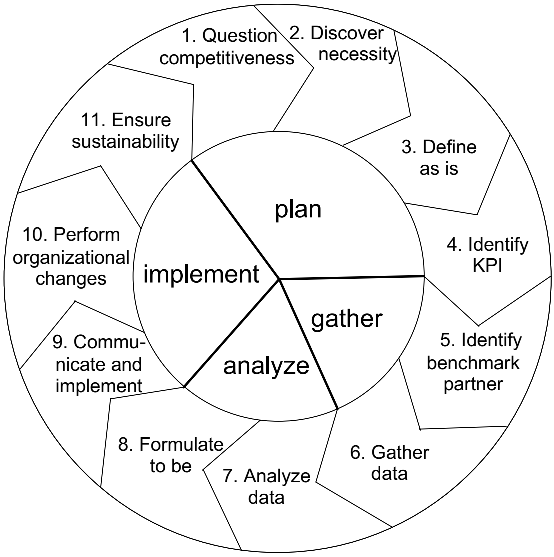
7.2 Using benchmarks

Benchmarking means to compare one business with another in order to improve one or both. Such a way of learning from the better or best is probably as old as humankind. It is clear that the approach can be used in business, too. But what is new about it? Why does it need an explanation in this book? To give a clear answer: There is nothing new about it. And it needs little explanation. Therefore, this subchapter is one of the shortest in this book. It does seem necessary, however, to explain what managers understand by the word benchmarking. In 7.2.1, I will stress the differences between benchmarking in the US and Europe. There are typical mistakes that people make in benchmarking, and these are addressed in 7.2.2.

7.2.1 Definition of benchmarking

Arguably, the word benchmarking and its use in business originate in the US. Instead of just comparing one thing with another, the Americans made an entire process from benchmarking. The situation is analogous to controlling. At its core is to compare the “as is” with the “to be.” It is in fact very reasonable to consider it an entire process, as I have done in 4. Analogous to Fig. 4-1 , one may display the benchmarking process as in Fig. 7-6. There, 11 steps are defined. It is a permanently running project with the four phases plan, gather, analyze, and implement. Because it runs again and again, it is more like the tasks of a controlling department rather than a typical

Fig. 7-6: *Typical display of (US) benchmarking process*



project. Therefore, some companies have benchmarking departments. Fig. 7-6 illustrates that the process begins by questioning the competitiveness of one's own company. Then, most likely it is necessary to improve that competitiveness. The status quo must first be defined. Then KPIs (key performance indicators) should be identified. These indicators should show unambiguously whether the business is running well or not, *and* they should allow comparison to other businesses. Although it is next to impossible to find perfect KPIs, one should try very hard to find reasonable ones. Having identified the KPIs, one should find partners for comparison that are "good" as measured by these KPIs. A firm may have a different partner for each KPI. Next, data must be gathered and analyzed. From this, the "to be" status should be formulated. The result should be communicated throughout the entire company, and feedback should be welcomed.

Otherwise, future implementation might be difficult. Most often, some organizational changes must be made to permit adoption, and an important goal is to ensure sustainability. After the circle is completed, one should not rest but begin again to question competitiveness.

Obviously, benchmarking as described above is more than just comparing. The process of Fig. 7-6 became fashionable in the US during the 1980s, and ever since it has been a part of the standard management process. Slightly later, benchmarking conquered Europe. There, the concept as an entire process vanished. The main activity left from Fig. 7-6 was "gather data." In particular, consultants created their own little databanks containing numbers such as: "1% of all employees are in the personnel department." or "The time to unload a pallet is 3 minutes." I remember being severely disappointed when the American branch of our consultancy sent me a "benchmark databank." Opening it did not reveal any number. It was just a table telling typical KPIs for different industries and for each KPI a company considered to be best in class. Such a databank appeared worthless to us. The reason for this difference originates in culture. In the US, it is quite easy to call a company and ask questions such as: "How many people are working in controlling in your company?" There is at least a good chance to get this question answered. In Europe, there is almost no chance that somebody will answer such a question. Trying to do so across Europe means also to overcome language barriers. A typical fear was that somebody was trying to steal some classified information. That is not too surprising, considering that I even remember young consultants disguised as students sneaking into companies. One would claim that he or she was writing a thesis for professor xy. Normally they obtained the information, because they did not appear to be spying for a competitor.

Such stories show that gathering benchmark data can be difficult. So difficult, in fact, that all other activities are negligible by comparison. This explains the different attitudes toward benchmarking in the US and Europe. In any case, I have to stress that I do not recommend gathering data (in whatever way) and then to start crunching numbers blindly (see also 7.2.2). The best way is to find a real partner for benchmarking. One should look for a similar company, maybe a direct competitor, but not a foe. The contacts should be made at the level of high-ranking executives. In a company that is not so big, the CEO is the person to talk to. Some old personal connections are definitely helpful. Making such contacts is more difficult in Europe than in the US, but it is not impossible in Europe. Having established such contact, one should talk very openly with the potential partner about what one is trying to do. One must emphasize that the flow of information is not to be a one-way street. Both partners will gain. The best way to prove openness is to present one's own data first. A two-hour discussion will at least identify the areas of interest, and normally this already explains a lot. Further talks at various levels and between experts from particular areas may follow. Again, openness, trust, and the will to achieve excellence mutually are keys to success. Furthermore, there should never be a blind exchange of numbers. My recommendation is to exchange only 10% or even 1% of the volume of data that is usually exchanged. But one should make sure to understand each and every number. Exchanging data by e-mail or fax will most likely not do the job, either. Speaking in person is indispensable. In the end, both sides should have ideas how to improve their respective businesses. Then projects should begin for working out the details and eventually to implement the changes.

The approach I am recommending here is neither the European hunter and gatherer approach nor is it as formal as the American approach of Fig. 7-6. It is the most suitable for avoiding the typical mistakes detailed in the next section.

7.2.2 Mistakes to avoid

In this section, I will list typical mistakes and other things to be avoided. Typically, these will not show up if the approach described above is taken. My list will be by no means complete. It represents the things I have personally observed. I will comment on each point further below.

- Do not abuse the generally high trust that is essential to benchmarking.
- Avoid ready-made databanks with numbers already inside.
- Remember that each number bears an error.
- Do not compare apples with oranges.
- Remember that benchmarking will not create fundamental change.
- Remember that today's leader may be tomorrow's loser.
- One should change the business not the benchmark value.

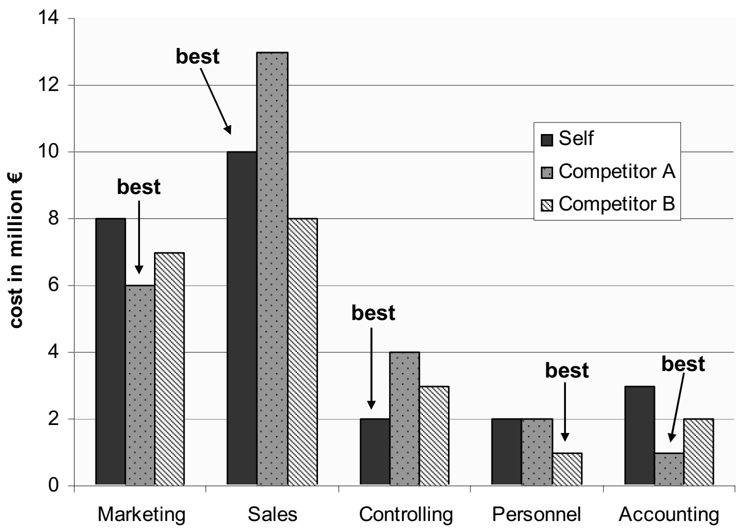
The first point about abusing the trust is an ethical concern. Normally, if a manager or consultant just says that in his or her opinion something can be done faster or cheaper the audience is hard to convince. It looks like an old trick to get people to work more for equal or even less pay. However, if someone states that in company x such and such is done in 20% less time people will normally trust it. It sounds authentic. Partly, it is a question of honor and self-respect to be as good as others. People will try very ambitiously. However, this mechanism should not be abused. There have been cases where certain benchmarks were invented. More often than not, that trick worked and people tried hard and (partly) successfully to improve their efficiency. Needless to say, I personally despise such tactics.

The second point (about ready-made databanks) I mentioned already in 7.2.1. There are entire books containing nothing but such benchmark data. Industry associations sometimes publish them. However, the circumstances as to how these values have been determined will remain unclear. Even if a statistical distribution rather than plain numbers is given, it does not help. Nobody knows whether he or she is average, above or below in the sense of the distribution. The only information is that others are doing it differently but not necessarily better.

The third point above stresses errors, as discussed intensively in section 6.1.2. In benchmarking, because it is very difficult to estimate the existing margin of error, people tend to accept what sounds reasonable. If the competitor is, say, 10% cheaper, then that is accepted. If the outcome is a 90% cheaper competitor, however, nobody will believe it. People will say there must be an error. An error may also exist in the case of the competitor appearing 10% cheaper. Perhaps in reality the competitor is 15% more expensive.

The fourth point (comparing apples with oranges) is sometimes thought to be the whole idea of a benchmark. As an example, consider benchmarking of cost. In Fig. 7-7 the cost for marketing, sales,

Fig. 7-7: *Faulty benchmark of cost*



controlling, personnel, and accounting are displayed for the company comparing itself ("Self"), Competitor A, and Competitor B. Sometimes Self is best (lowest cost) but sometimes not. In order to be the best, Self should have the lowest costs in each of the five categories. Therefore, the total cost of 8 + 10 + 2 + 2 + 3 = €25 million should be reduced to 6 + 10 + 2 + 1 + 1 = €20 million. Sometimes, consultants sell this as proof of potential cost savings of €5 million. This is complete nonsense. Though the three companies under consideration may be similar, the roles and responsibilities of the departments may vary. Take controlling and accounting as an example,. At Self, it is probably pure controlling with no accounting. Competitor A may perform most of its accounting in the controlling department, while the accounting department does the tax accounting only. That is why its accounting cost is so low.

The fifth point above should remind the reader that benchmarking shows what others do well. Ideally, one may become as good as the best today. However, one will not become much better. In order to excel one needs fundamentally new ideas.

The sixth point above says that somebody who is excellent today may or may not stay this way. To use benchmarking and follow the (presently) best is not always good advice. To take an old example, one should go back 40 years and consider the automotive industry. Back then, the leaders were the so-called Big Three in the US. The emerging automotive industry in Japan did not benchmark themselves against the leaders. Though often accused of copying, they found in fact their own way.

The last point about changing the benchmark rather than the business refers to something else that is frequently done. As stated already, benchmarking identifies areas where one should improve, but it does not tell how to improve. Therefore, quite often the top management takes the results from benchmarking and assigns these values as targets to their subordinates. For the latter, it is sometimes very difficult to find ways to improve the situation. Therefore, they will do all they can to at least make the required numbers look nice. For example, if somebody upstairs wants lower purchasing costs, the subordinate may begin insourcing what used to be outsourced. The result: lower purchasing costs but higher production costs. Another infamous example is among companies that want to go public. They are going to be scrutinized by analysts, and benchmarks of financial indicators will be used to estimate the company's value. People inside the company know such financial indicators and they will make them look nice through so-called "creative accounting."

7.3 Learning curves

As probably every reader knows from personal experience, doing something several times improves efficiency. One learns to avoid the mistakes made earlier. In production, it is well known that producing the first 100 pieces is much more expensive than is producing the next 100 pieces. Indeed, such learning applies to all areas of business where something new is done. Describing such so-called learning curves is the content of this chapter.

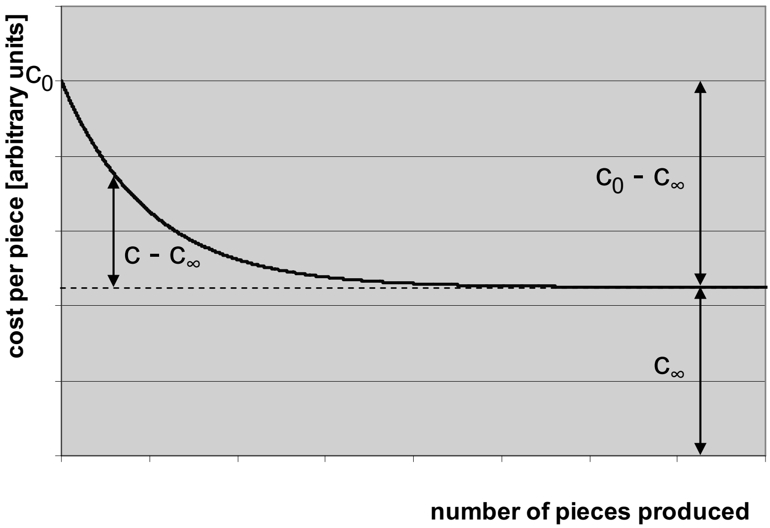
Having a mathematical description as to how learning takes place is quite valuable for controlling and cost accounting. In addition to knowing what something costs today, it is indispensable to at least estimate the cost in the future. In subchapter 7.3.1, a mathematical model shows that learning curves are exponential functions. In 7.3.2, I will show how controlling works when learning curves are considered.

Please note that theories and formulas for learning curves are published in many books. All sources I know, however, take an approach that is quite different from the one presented here.

7.3.1 Theory of learning curves

A typical form of a learning curve is displayed in Fig. 7-8. In the beginning, the cost per piece is c_0. Over time, it will gradually decrease. Of course, it will not go to zero. Eventually, all mistakes will be avoided, there will be perfect efficiency, and the cost per piece will be reduced to c_∞. On the horizontal axis, I have chosen the variable "number of pieces produced" (N). Alternatively, one may choose elapsed time as a variable (as I will do in 7.3.2.). Of course, taking time as a variable assumes the new process is performed continually over that time. If this is not continuous, then one could perhaps count just those times when the process is running, but choosing number of pieces as a variable seems to avoid the problem.

Fig. 7-8: *Typical form of decreasing cost due to learning*



On the other hand, producing one batch of 1,000 pieces will most likely result in less learning than will producing 10 batches of 100 pieces each. So maybe N should be the number of batches rather than the number of pieces. In any case, one should take a reasonable definition and then stick to that particular definition all the time. In order to find a mathematical formula for the curve of Fig. 7-8, one should realize that learning is easiest when one knows least. Typically, the first mistake will be discovered most easily and the last with the most difficulty. Therefore, the change (decrease) in cost Δc will be proportional to the distance to its final value c_∞ or

$$\Delta c \propto -(c - c_\infty)$$

This translates into the differential equation

$$\frac{dc}{dN} = -\frac{1}{N_0}(c - c_\infty)$$

where N_0 is a constant with the dimension of pieces (like N). The differential equation is easily solved by separation of variables and integration on both sides:

$$\int_{c_0}^{c} \frac{dc'}{c' - c_\infty} = -\frac{1}{N_0}\int_0^N dN'$$

Solving the integrals leads to the final result in the form

$$c = (c_0 - c_\infty)\cdot e^{-\frac{N}{N_0}} + c_\infty$$

Replacing N with t and N_0 with τ leads to a version where time t is the variable. The constant c_0 is the cost in the beginning. The constant c_∞ must be estimated or it can be calculated from the design of the ideal (theoretical) process. The constant $c_0 - c_\infty$ is the maximum amount that can be learned. It resembles how far one is apart from the ideal process in the beginning. The constant N_0 (or τ) determines the speed of learning. A big N_0 (or τ) means fast learning.

7.3.2 Controlling with learning curves

In this section, I will show a typical application of the formula for the learning curve. In the case of a new process (not necessarily in production), one will most likely have a learning curve that implies a significant cost reduction over time. Especially from the controlling point of view, one will ask the following questions:

- How should one control whether the learning takes place as planned? What is the proper "to be" value at any time?
- What will be my cost at any given time?
- What will be my average cost over some period? (This is necessary, e.g., for determining the break-even point.)

In this section, I will answer these questions by applying the formula for the learning curve. Taking the time as a variable, the formula reads:

$$c = (c_0 - c_\infty) \cdot e^{-\frac{t}{\tau}} + c_\infty$$

The initial cost c_0 is supposed to be known. The eventual cost c_∞ must be estimated. One way is by taking the theoretical (ideal) process and setting a cost factor for each step. This is nothing but the bottom up approach as stated in the chapter about activity based costing (6.3.1). Alternatively, one may just ask experienced people for a qualified guess of c_∞. One should have a mutual agreement on this value. Normally getting a commitment for a certain c_∞ is quite easy, because one has an infinite amount of time to reach this value. However, knowing c_0 and c_∞ does not help until τ is known. A good way to get it is to ask the people involved how long it will take to reach half of the eventual cost savings. I call this time period $t_{1/2}$. It is the time for which

$$c(t = t_{1/2}) = (c_0 - c_\infty) \cdot e^{-\frac{t_{1/2}}{\tau}} + c_\infty = (c_0 - c_\infty)/2 + c_\infty$$

holds. This equation can be solved for τ easily. Its result is:

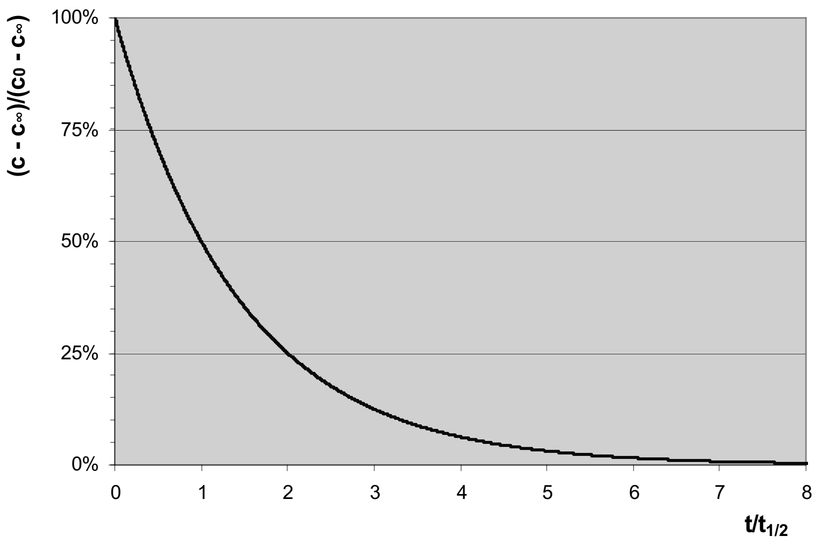
$$\tau = \frac{t_{1/2}}{\ln 2}$$

With it, the cost function takes the form

$$c = (c_0 - c_\infty) \cdot e^{-\frac{t}{t_{1/2}} \cdot \ln 2} + c_\infty$$

This is already the answer to the questions of the first two points above. As an example let us take an initial cost of 100 €/piece (= c_0). It is estimated that this eventually will come down to 70 €/piece (= c_∞) and that half of the potential cost reduction will be reached within a year ($t_{1/2}$ = 1 year). Knowing the values of the constants, one can calculate the cost for any given time t. The result has been displayed graphically in Fig. 7-9. In the example just presented, the cost per piece should be €85 after one year. In order to control it, one should know the cost after say half a year. Half a year means $t/t_{1/2}$ = 0.5 year/1 year = 0.5. From Fig. 7-9, one obtains for this value a $(c - c_\infty)/(c_0 - c_\infty)$ of 70.7%. So the cost after half a year should be (€100 – €70) · 0.707 + €70 = €91.21. In the

Fig. 7-9: *Decreasing cost if $t_{1/2}$ is given*



same way, one obtains an expected cost after, for example, three years ($t/t_{1/2} = 3$) of (€100 – €70) · 0.125 + €70 = €73.75.

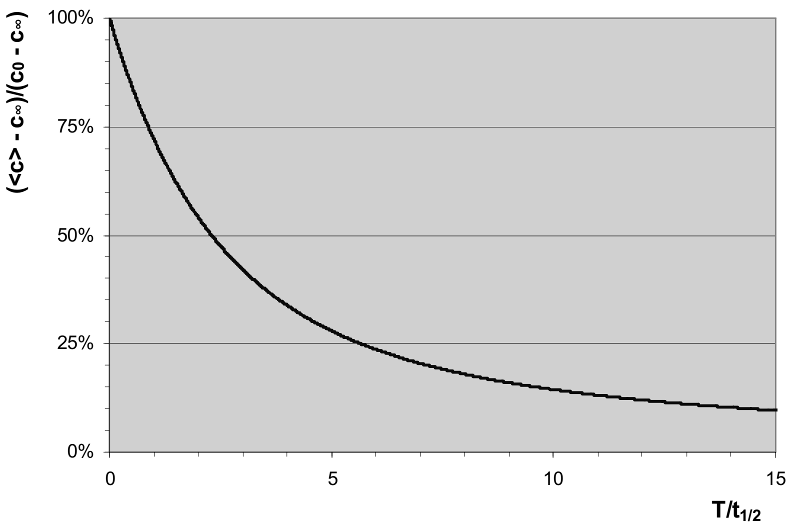
Besides knowing the cost at any future time, it is important to know the average cost. This is necessary in order to find a break-even point. Although cost will vary in accordance with the learning curve, prices are normally market prices and are more or less fixed. In order to find the average cost <c> over some period of time T, one has to integrate the cost function.

$$< c > = \frac{(c_0 - c_\infty)}{T} \cdot \int_0^T dt \cdot (e^{-\frac{t}{t_{1/2}} \cdot \ln 2} + c_\infty)$$

Solving the integral leads to

$$< c > = \frac{(c_0 - c_\infty)}{\ln 2} \cdot \frac{t_{1/2}}{T} \cdot (1 - e^{\frac{T}{t_{1/2}} \cdot \ln 2})$$

Fig. 7-10: *Average cost <c> over a period T*



In Fig. 7-10, the average cost has been displayed graphically. Taking the values from the example above, one can, for example find the average cost for three years as follows: If $T/t_{1/2}$ = 3 years/1 year = 3, then $(\langle c \rangle - c_\infty)/(c_0 - c_\infty)$ has a value of 42.1%. So the average cost $\langle c \rangle$ = (€100 – €70) · 0.421 + €70 = €82.83. That means selling the product over three years for €82.83 would just break even. Please note that constant sales figures are assumed here. If that is not the case, then one has to include a corresponding factor under the integral above. Finding a break-even period is of course also possible. Selling at a price of €80, for example, will lead to a break-even period of 4.61 years.

All questions asked in the beginning of this subchapter are now answered. The required mathematics may look "ugly" for some readers, but there is no other way to start a proper controlling when learning curves are essential. Taking the controlling approach presented here may or may not lead to "as is" values close to the "to be" values. If not, the reason may be just sloppy management. However, it is also possible that the "to be" values are wrong. Here, they are based upon estimates for c_∞ and $t_{1/2}$, and such estimates are not always precise. One may obtain precise values by observing the cost for some trial period (e.g., six cost values for the first six months). These, then, can be used in order to obtain the values for τ (or N_0) and c_∞ as fit parameters. Doing so by applying a least squares fit method, for example, will also reveal the margin of error.

7.4 Soft skills

In keeping with its title, this book explains methods and tools that a manager needs to know to do his or her job. These are necessary, for example, to find the optimal organization. Quite often, I have emphasized psychological effects. Finding a proper organization is one thing; making people work in that organization is quite another question. In addition to the hard facts, one has to consider soft facts.

From my experience as a manager and consultant, I know that the soft skills are much more important than any knowledge of methods, tools, and facts. Judging from this experience, 90% of this book should perhaps be about soft skills. However, there are two reasons for dedicating less than 10% of this book to the field of soft skills. In the beginning, I had even thought about not including them at all. First, there are many books about soft skills, and I do not claim to contribute anything new. Second, and even much more importantly, it is difficult to teach soft skills, and especially from the pages of a book. The best way is to learn by experience, and maybe with the help of a good coach. Learning them theoretically is like taking theoretical driving lessons. The purpose of this chapter, therefore, is only to specify the main problem areas. I hope it also will help readers to discover their specific deficits and provide some hints on overcoming them.

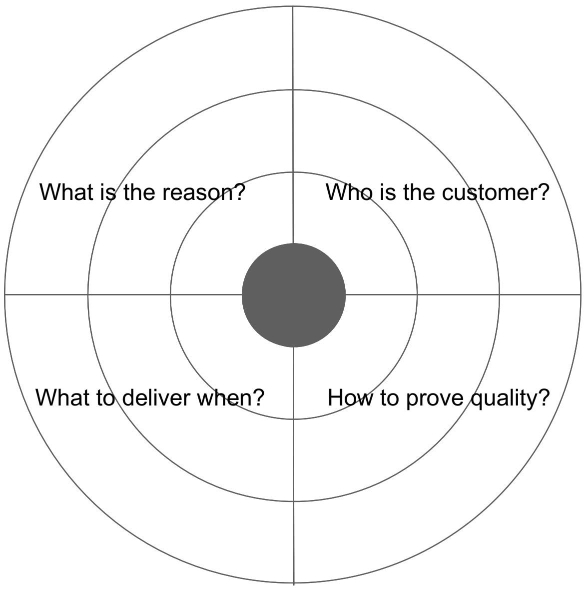
The four areas I will discuss in this chapter are from my own experience the most important ones. Many devastating mistakes originate from these areas. In 7.4.1, I will explain how to define goals. It is assumed that one knows the content of those goals. The point is how to describe them simply but unambiguously. In 7.4.2, I will provide a guideline on how to give and receive feedback. This is perhaps one area where it is even more important to be able to receive than to give. Next, because most managers spend 50% to 90% of their time in meetings, these ought to be extremely efficient. Some hints toward achieving that are summarized in 7.4.3. In the last section (7.4.4), I will distinguish between "managing" and "leading." I will stress what is important for leading other people (in business).

7.4.1 Defining goals

In chapter 3 (balanced scorecard), I have described how to set goals such as "increase punctuality by 3%." In this chapter, I will present an easy way to formulate a goal unambiguously. Even with this seemingly precise goal "increase punctuality by 3%," it is not really clear what to do. The German airline Lufthansa once increased punctuality of its domestic flights dramatically just by extending the scheduled flight times by 15 minutes. There was no change in its operations. Nevertheless, it was a very smart move. Passengers were extremely pleased. They didn't mind the extra 15 minutes. They just hated the *feeling* of being late. In order to consider this solution for increasing punctuality, one had to have some background knowledge. Here, one needed to know who was demanding greater punctuality and for what reason.

In order to understand a goal one needs background knowledge. For global goals, such background information is mostly available and the reason for pursuing the task at hand is known. For assignments that are not so fundamental, people normally do not bother to ask for the background. They think (mistakenly) that everything is clear. So one

Fig. 7-11: *Questions to define a target*



needs a *simple* way to define the exact target one is to head for. A straightforward approach is to ask four[12] simple questions as displayed in Fig. 7-11. The first question (What is the reason?) defines the underlying problem. It describes the reason why something must be done. In addition to clarifying the target, it helps to motivate people. The second question (Who is the customer?) is about who will receive the result. Please note that there is sometimes both a direct customer and an indirect one. The direct customer is the one handing out the problem. The solution is reported to him or her. In business, this is normally the boss of the person performing the task. Quite often, the direct customer is just a mediator. He or she gives it to somebody else (e.g., his or her boss). This final customer is the indirect customer. Before performing a task, one should know both the direct and the indirect customer – and the latter one is most important. He or she clarifies whether, for example, the result should be presented in a detailed, 100-page report or a colorful PowerPoint presentation. The answer to the third question (What to deliver when?) should describe exactly what is expected and when. A typical example is something like this: "A PowerPoint presentation of 10 to 15 charts similar to the attached pattern by 4 p.m. tomorrow." Please note that a task may have several outputs. Each may be in a different form and all may be due at different times. Moreover, the due date should not be understood as a deadline only. It also clarifies what is expected. If somebody demands a market analysis by tomorrow afternoon, it will be different from one that is due next month. The last question (How to prove quality?) concerns the controlling. There should be a clear way to verify whether the result is as demanded or not. Typically, if the three previous questions are answered precisely the fourth is almost superfluous. Nevertheless, one must have a clear-cut mechanism to substantiate the quality. As a consultant, it is a typical question of mine to ask a particular middle manager whether his or her day was "successful." Normally the person is quite bewildered by this question. Obviously, he or she accomplished something during

[12] Asian readers are supposed to count "What to deliver when?" as two questions, resulting in a total number of five.

that day, but it is not possible to judge about the quality on a scale of, say, 1 to 10. Clearly, nobody ever bothered about the question how to prove quality.

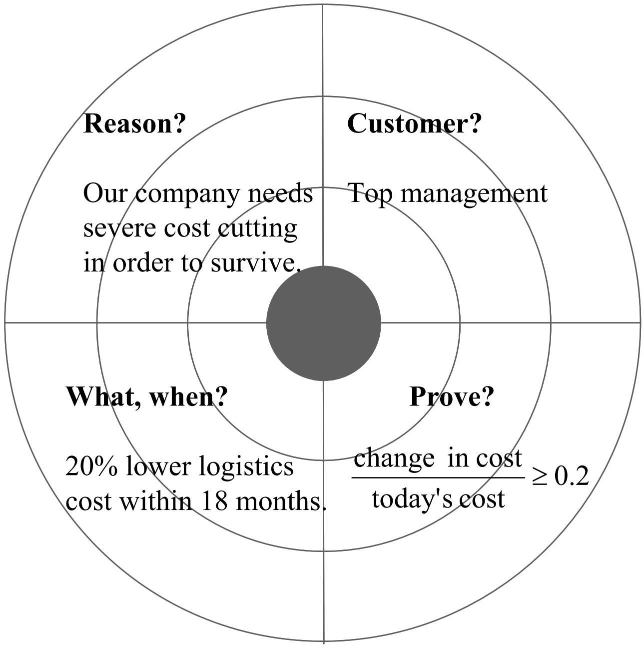
The final question is so notoriously ignored that I want to stress its importance by telling a true story. Some time ago, I had a discussion with the general manager of a company producing electrical motors and an IT manager of a university. The IT manager told us that wasted quantities of data were downloaded from pornographic sites, which are obviously unconnected to the business of a university. Hearing that, the general manager became furious. Not because of any moral outrage, but because it became obvious to him that at least some people are surfing the internet for private purposes several hours a day instead of working. So he asked about legal measures to supervise internet use in order to curb this. The discussion clearly demonstrates a severe management problem. Clearly, the only way to prove the quality of the (white collar) workers was the period of time they sit at their desks, seemingly working. There was no other mechanism to check their results. It must be in the best interest of a company to respect a person performing far above average even though he or she might do private things like surfing the internet. On the other hand, a person performing constantly far below the average should be sacked even if he or she never does private things during working hours. In order to make either decision, one needs performance measures. The simplest version of this is the answer to the question how to prove quality in Fig. 7-11. Taking “time spent working” as the only measure of output is so widely accepted that even top experts use it. Top management consultants charging €3,000 and more per day quite often are ordered to stay longer at the client’s site than the management. If they leave the client’s site in the evening, it is a common trick to let the light burn. Programming e-mails to leave the PC at 3 a.m. is also not so uncommon.

Critics of the rules of Fig. 7-11, how to define targets, may say that it is just common sense. I absolutely agree with this point of view. But I have to add: “Unfortunately it is not so common.” Not the content of Fig. 7-11 is important but its application. Upon receiving a task to do, one should always ask the questions of Fig. 7-11. If there is nobody available to answer them, one should at least think about possible answers. All this should be done in a *written* form. I personally do so even for tasks nobody assigned to me, like writing this book. Especially if a team of people are working on something there must be a mutual agreement on the target as defined in Fig. 7-11. I personally have experienced many meetings that lasted far after midnight involving very heated discussions. In hindsight, it is absolutely clear to me that everybody in the room had a target. Unfortunately, the target differed from person to person, but nobody was aware of that.

Managers giving tasks to their subordinates must define the goals, as well. They should also provide answers to the questions of Fig. 7-11. In reality, this is rarely done. In most cases where subordinates do not perform the assigned tasks, it is because they had no clue what to do. Pure laziness is rarely the reason. There are even cases where managers get assignments from their bosses and these bosses have no idea how to define the targets. The one boss was too timid to ask the higher boss. Instead, he or she just passes the task off to subordinates.

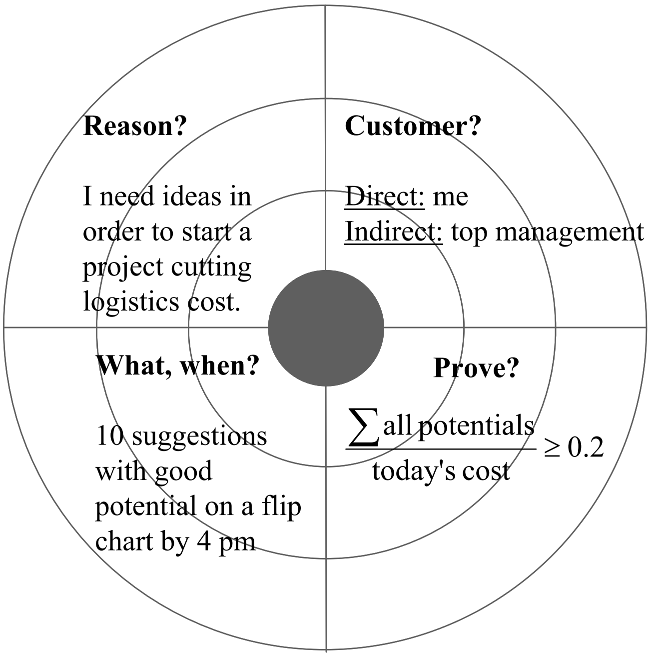
To close this section, I will present a case where defining the target was done incorrectly. The top management had been forced into a severe cost cutting. One promising area for savings appeared to be in logistics. It seemed feasible to save 20% there. Therefore, they called in an appropriate middle manager, explained the background extensively, and assigned him the task to lower the logistics cost by 20% within 18 months. He should build and lead a suitable project team. Eager to do this job, he calls a meeting. He invites follow middle managers who are supposed to put together the project team. Because every meeting needs a target, he draws the target of Fig. 7-12 on a

Fig. 7-12: *Target for kickoff meeting (incorrect)*



flipchart in the beginning of the kickoff meeting. Why is this target complete nonsense? Readers who want an exercise should stop reading here. Others may find a possible solution in Fig. 7-13. The target of Fig. 7-12 is a possible target for the entire project. Formally speaking, a meeting with such a target must last for 18 months. But it is not formality that makes the target definition of Fig. 7-12 incorrect. Such a meeting may or may not be a useful first step. The point is that one cannot tell after the meeting whether it was successful or not. Probably it brought about something useful for lowering the logistics cost, but nobody can tell whether or not it was enough. Month 18 is still far in the future, so at least an optimist will always claim that everything is moving along fine. In contrast to Fig. 7-12, Fig. 7-13 contains a possible definition of a target. Of course, there is more than one solution. With a target like that in Fig. 7-13, the meeting has a clear result. It is a flipchart containing 10 ideas for saving logistics costs.

Fig. 7-13: Target for kickoff meeting (possible definition)



Each idea has a number indicating its potential, and the sum of all potentials must be high enough that the desired 20% is reached.

7.4.2 How to give and receive feedback

Probably every reader of this book has experience in giving or receiving feedback. Controlling (chapter 4) is supposed to give feedback as to how a business is doing, and there are many more situations where one person gives feedback to another. In this section, I will describe a situation where two people, or perhaps a group, decide on their own to give mutual feedback. As an example, consider two colleagues working together for some time. Perhaps they will meet to exchange views on one another's strengths and weaknesses.

The main goal for giving and receiving feedback should be mutual improvement. Please note that I do not refer here to an annual performance evaluation whereby a person receives feedback in order to justify a bonus payment or promotion.

Skills are required on both the giving and receiving sides. Especially in the passive role of receiving feedback, these skills are often neglected (see story below). There are three important guidelines for receiving feedback:

- Receiving feedback provides a chance to excel.
- The recipient of feedback must neither feel hurt nor become angry.
- Feedback should be a mutual thing.

The first point is most important. Quite often, people try to get positive feedback in order to become promoted. As a result, only their salaries will excel. If the feedback recipient is in some way hurt or becomes angry, he or she will not listen any more. Rather, that individual will try to defend himself or herself. Because feedback is supposed to remove problems *between* people, it must be something that is done mutually. Therefore, person A gives feedback to B and afterward B gives feedback to A.

In order to achieve a positive effect from feedback the sender of feedback must also obey some rules:

- To give feedback is to inform. It neither means lecturing nor is it supposed to be an action to relieve stress (let off steam).
- The positive things must be dominant. At least they should come first.
- Concrete examples are much better than abstract generalizations.
- Never, ever try to humiliate or insult the other person.

A boss may be especially tempted to lecture his subordinates instead of informing them. Emphasizing the positive is important, first because people are more willing to listen to the positive and second because knowing what is done well means one should do it again. Knowing the wrong way does not necessarily point to the correct way. Presenting the positive things first enables the recipient to open up. It is also easier for the person providing feedback to say the positive things first. Especially if the recipient is the boss, telling the positive things first is much easier. Especially people with academic educations tend to translate examples of daily behavior into abstractions. (Some even consider it the very idea of working scientifically.) But doing so is not helpful to the feedback process. For example, compare the following two formulations of the same thing.

abstract: Your punctuality is not sufficient.
concrete: Yesterday our meeting was scheduled at 3 p.m. You appeared at 3.30 p.m.

The abstract formulation will push the receiver into a defensive role. He or she will at least think about whether or not the punctuality is really insufficient. Perhaps other people are even much less punctual. In contrast, the concrete formulation will not provoke defensive moves. It is a statement of facts.

As a negative example of receiving feedback, consider the following true story.[13] Two young junior product managers of a multinational consumer goods company met in the bathroom. One was complaining about this arrogant marketing director. Then the door of the stall opened and the marketing director came out. He ordered the complaining junior product manager to come to his office at 3 p.m., at which time the junior product manager was fired on the spot. One lesson may be that having separate bathrooms for senior managers is not such a bad idea, after all. But the more important fact is that the marketing director was completely unable to receive feedback. Probably having just received his first honest feedback from a junior

[13] I am indebted to Heinz Schoefer for telling me this story.

product manager in the last 20 years, he missed the chance for any improvement.

Before closing this section, I will give a few remarks on how often one should have a feedback session. The simplest answer is: “As often as necessary. And better one time too often than too rarely.” Typically, people just starting to work together should give one another feedback more often than those working together for 20 years. A bigger meeting should also include a short time (5 minutes) for feedback at the end. I have to stress, however, that one can overdo it. In a big US consultancy where I used to work, I had to give and/or receive feedback about three times per day. In the morning, I led a meeting with a group of clients. At the end, I asked for “benefits and concerns (Bs & Cs),” as we called the feedback process. I wrote all Bs and Cs on a flipchart. For each C, I noted who should do what and when in order to avoid the shortcoming next time. In the afternoon, the same procedure was followed in another client group. In the evening, we had an internal meeting. Of course, in the end Bs and Cs were given. The main point is that almost all consultants and clients were totally fed up with feedback. People offered only standard and innocuous remarks and hoped it would be over quickly. This procedure ruled out the possibility that any real and serious concerns would be expressed, but it also made it impossible for anybody to claim after six weeks, say, that the project had gone in the wrong direction, because everybody had had an opportunity several times daily to remark on what he or she disliked.

7.4.3 Managing meetings

There is scarcely any manager who spends less than half of his or her time in meetings, and spending even 80% of the working time in meetings is by no means rare. Then, too, many managers complain that their meetings are inefficient Consequently, anybody who wants to improve the efficiency in management should start with the efficiency in meetings. The problems fall into two categories:

- There are too many meetings. Not everything should be done through teamwork.
- There is a set of typical errors that characterize most meetings.

The first point (too many meetings) is a misinterpretation of the discovery that teamwork *sometimes* improves efficiency dramatically. For whatever reason, people transformed this finding into: "Teamwork always improves efficiency, at least slightly." In fact, there should be a reason why some process is performed in a meeting.[14] In order to find out typical reasons one should look at the things people find positive about meetings. These are:

- The results are much more easily accepted.
- One gets the viewpoints from different departments and hierarchies.
- A fun atmosphere fosters creativity.

Working out a result and getting it accepted by other people are two distinct tasks. In business, the latter is normally much more difficult. The result of a meeting is at least accepted by those people in the group, which is a much better starting condition. Depending on the details of the organization, working with different departments and hierarchies is difficult, but communicating across hierarchies can be very fruitful. If somebody would ask me to name one thing making me as a consultant superior to an in-house manager, I would say it is talking to *all* hierarchies. It is true that meetings are ideal for overcoming the barriers of hierarchy. The last point above, about fun and creativity, is arguably by far the most important positive feature of a meeting. Because creative ideas are in short supply, we always are

[14] By "meeting," I mean a group of people coming together in order to work out something. Sometimes people come together just for the exchange of information. Such "meetings" are not considered here. In the modern age of information technology, these are mostly superfluous.

trying to find out what makes people more creative. One stereotype already proven false is that young people are more creative than old ones. It is proven, though, that a fun atmosphere fosters creativity. Meetings generating such an atmosphere can bring forward creative ideas. Therefore, an offsite meeting in a nice hotel is by no means a waste of company money.

So much for the list of positive things about meetings. One could perhaps come up with some more positives, but, basically, at least one of the features I have mentioned must exist in order to justify a meeting. If one realizes, for example, that creative ideas are needed, then there could be justification for calling a meeting to gather ideas.

If a meeting is truly necessary, then there are typical mistakes to be avoided. From my own meeting experience and various seminars on meetings management that I have given, I can point to the following mistakes:

- The goal of the meeting has not been defined.
- There is a lack of discipline.
- People are overly eager to demonstrate their own importance.
- The outcome of the meeting has been determined beforehand.

Not having a well-defined goal or target has to do with meeting preparation. The procedure from 7.4.1 is ideal for meetings. Coming to a mutual agreement as to the target may take easily half an hour or longer, but it is by no means a waste of time. Everything done together with other people requires some discipline. One has to obey certain rules. For example, all must arrive at the same time and one cannot make a phone call just because one desires to do so. The first step towards obeying rules is to have them. Therefore, I highly recommend formulating a set of rules as the first activity in a meeting. They should be written on a flipchart and must be mutually agreed upon. There should be a sanction for violating a particular rule (e.g., a ringing mobile phone costs €5). Such rules can be used also in subsequent meetings if the same group is to meet again. Promoting oneself is a frequent misuse of meetings. Particular meeting setups foster such misuse. Some companies have something like the "monthly meeting of the department heads." By and large, this is something like a movie festival where "to see and be seen" are most important. The last point (predetermined outcome) represents the most destructive error. Unfortunately, it is quite common. Sometimes an unpopular decision has been taken. Because the person in charge is afraid to be held accountable, he or she might call a meeting. The name of the game is to bring the team in the meeting to the point that they think they made the unpopular decision. Consultants are experts in doing so. I had quite some psychological training to learn how to "persuade" people in this way. Although I applied it seemingly successfully, I was not always particularly pleased with myself. It is not just an ethical concern, either. To have a meeting where the outcome is clear beforehand can lead to one of two situations. The first possibility is that people may consciously recognize what is going on. This is the harmless outcome. Some people might become angry and others may find it ridiculous, but, in any case, it is an absurdity that can be pardoned. The second possibility is that people will notice it unconsciously. Then they just have the *feeling* that somebody lied to them. Trust may be destroyed forever. Some people claim that there might be a third outcome in which the people do not notice at all. I have never observed this. There is no rigorous proof, but I think it is impossible. I have met self-confident managers claiming that their subordinates will never find out about a result being established beforehand. Further investigations, though, always have led to the conclusion that such managers' self-assurance on the matter was wholly unjustified.

So far, I have discussed the typical mistakes in setting up a meeting. The process of running a meeting is best learnt by doing it and receiving feedback. Such a trial-and-error approach cannot be taught in a book. All I can do here is to define the roles and responsibilities in a meeting. Although these are normally known in principle, I frequently observed them being confused in reality. In Fig. 7-13, the principle roles are displayed. There are three parties: moderator, team, and customer. In the following paragraphs, I will comment on these three parties.

Fig. 7-14: *Roles and responsibilities in a meeting*

One must learn most to function well in the moderator's role. He or she manages the meeting and leads the team. The moderator is accountable for running the meeting but neither for the content of the agenda nor the results. He or she prepares the meeting. There must be a suitable room and media (flipchart, beamer, etc.). Breaks during which drinks and maybe snacks are served must be scheduled. Although the moderator is not supposed to set the target of the meeting, he or she must bring the team to a mutual agreement upon it. The method from 7.4.1 is ideal for this purpose. The moderator leads the team to bring forward the most suitable ideas. For this purpose, he or she may use methods such as brainstorming or micro work groups of two team members each. But the moderator always remains neutral. The moderator will not bring forward ideas of his or her own. Neither should the moderator make judgments about the ideas, although he or she may, for example, ask the team to judge a list of ideas in order to set priorities. The moderator is in contact with the customer of the meeting (see below) and will most likely prepare the minutes.

The team is the "machine" doing the work. It typically consists of three to 10 people. In general, such people should be inhomogeneous. They should be different in order to bring forward different points of view. Having very similar experts on the team will probably create rivalries. Of course, the various experts on the team must have something to do with the problem under discussion. On the other hand, they should not be directly concerned. Otherwise, self-interest will dominate. Suitable compromises must be found. As noted above, fun fosters creativity. Therefore, everything possible should be done to create and preserve a pleasant atmosphere for the team.

The customer of the meeting is the person who owns the problem to be solved. He or she will communicate the problem to the moderator. The moderator makes sure that the problem is well defined and translates it into a target for the meeting. In the end, the customer will receive the results from the moderator. The customer decides about accepting the results. Although the customer is not a member of the team, he or she may or may not join the meeting. It is hard to say whether he or she should or should not join. A big American consultancy had an approach called PSTB (problem solving team building). There, the customer was always present. The benefits of this are obvious. At any stage of the meeting, the customer may interfere in order to steer it into the required direction. Furthermore, the moderator can always ask whether, for example, the number of ideas is sufficient. The main concern about a customer's joining the meeting is that the customer is more often than not the boss of at least some people on the team. Therefore, people will not talk so freely. Furthermore, the customer normally does not have the time to join all of his or her meetings. I personally favor meetings without having the customer present. From my personal experience, such meetings are more fruitful.

Everybody can agree that the three groups exist, but sometimes the borders between them get blurred (or crossed). From the above it should be clear that this will lead to problems. If, for example, the moderator is also the customer (and maybe boss) he or she will hardly remain neutral. The same will be true if the moderator is simultaneously a team member. Choosing a suitable moderator is the most important step towards a successful meeting. It is a smart move to take a moderator from a different department not involved in the problem. A consultant from outside is also a good choice (but not a consultant working in a project that is the subject of the meeting). As stated above, the moderator is not supposed to bring in ideas of his or her own. The easiest way to guarantee that is by having a moderator who is not expert in the field under discussion. I work as a moderator quite frequently. In cases where I happen to be an expert, it is most difficult to stay neutral and the results to date have mostly been below average.

7.4.4 Leading and managing

In contrast to the "hard" facts of this book, 7.4 deals with soft skills. There exists a brought range of opinions in this field, and I do not claim that mine are best. I do think, though, that they contributed quite substantially to the success of my work. In this section, I will write about my very personal opinions. It is not my intention to persuade the reader of my beliefs. More important is that the reader will form his or her own opinions. There is no right or wrong, except that it is definitely wrong to have no opinion at all. In the rest of this section, I will first explain the difference between managing and leading. Then I will offer my view about proper leading.

Leading and managing are two distinct tasks. Not all of my fellow scholars think it is reasonable to distinguish between the two. But I gained quite some insight from doing so. With the exception of subchapter 7.4, this book is about management skills. A manager decides how something is done, whether it is smart to invest a particular amount of money into something, or what planning procedure should be applied. In order to do so, he or she probably needs a good bit of higher education. Typically, a business school teaches such things. If it is clear what should be done and how, then the people responsible for it must do it. Bringing them to do it as well as possible is the task of a leader. For some people, it is sufficient to read an e-mail in order to get a proper description of the task to be carried out. Another person wants to drink a cup of coffee with his or her boss before the assignment starts. Some may say the latter subordinate is inferior to the first one because he or she takes up a half hour of management time. Perhaps, though, without the cup of coffee he or she would work three weeks on the job while adding this personal touch will reduce the workload to one week. Then, too, maybe the person with the e-mail always performs such tasks in two weeks. Please realize that such differences in work performance are by no means unrealistic. Nor are they due to a lack of information. It is the "personal touch" that makes the miracle.

With this definition of "leader" and "manager," respectively, the following becomes clear. It is possible to say that somebody is a better manager than is somebody else. In management, it is possible to state that some decision is better than another. Maybe it is difficult to judge, but in *principle* there is a better and a poorer decision. This is in contrast to the quality of a leader. Leading involves by definition at least two people. Therefore, the quality of leading cannot be assigned to one person (the leader). Speaking less theoretically, a leader may be stupendously successful in leading group A yet lousy with group B. It is easy to find examples of this in reality. I have in mind the case of a person who was the successful leader of a big R&D group. Later, he was transferred to lead a production department, and there he almost failed.

A quite interesting study in this context is a survey that compared management and leadership in the US and Germany. The study is quite old and covered the 1970s and early 1980s. The finding was that the Americans were good managers but not so good as leaders. In Germany, it was vice versa. They scored high in leadership but poor in management. Considering the period of the study, the explanation for the result is quite easy. In the US, business schools have a quite long tradition, and management is essentially the content of their curricula. By contrast, there were practically no business schools in Germany prior to the 1970s, and what business was taught at the universities was considered science rather than practical management. This explains the scores in management but not necessarily those in leadership. Leadership is hard to teach. At most, one can improve a natural talent by proper coaching. Many management scholars do not like the emotional side of leadership. In contrast to management skills, it is difficult to pin down. Take, for example, job interviews. Somebody invited for an interview is almost certainly qualified from the viewpoint of his or her technical or managerial skills. Typically, these areas are not tested during such interviews. The interview should make clear whether the candidate would fit into the company. The leader and person to be led must be able to accept one another. Of course, emotions play a major role in this decision. It comes as no surprise that psychologists have proven rigorously that the decision in a job interview typically is made after 10 minutes. So why does an interview take around 60 minutes? The answer is easy. People do not want to admit that they decide in accordance with their feelings. Mostly developed at business schools, there are systematic questionnaires available for job interviews. These assign grades to categories like "interpersonal skills." So an interview ends with a total grade and the candidate with the highest grade is supposed to be chosen. Doing so sounds systematic and almost scientific. However, it is ridiculous! The decision in a job interview is made after 10 minutes, and one of the leading motives for this decision is the smell[15] of the

[15] No special perfume will help. Normally such smell occurs on the unconscious level only.

person. I always compare such grade-based interviews to a situation where a person takes out somebody else for a date. Maybe he or she is wondering whether to get serious with the other person. But instead of relying on feelings, a scorecard is filled out. Does he or she like kids? Attitude towards religion, politics, etc.? All these questions are definitely important for a good relationship, but it would be completely ridicules to marry the person with the highest score. While it is politically correct to show emotions in a personal relationship, it is at best out of fashion even to acknowledge that emotions exist at all in a business relationship. Both cases deal with humans and relationships, however, and we are what we are: humans! By the way this fact is by no means a bad thing for business. Among other differences, humans and animals are distinguished by two main areas: Humans are intellectually superior and show many more emotions than do animals. Quite recent discoveries as to how the brain works show that the emotions are the cause of the intellect rather than a nasty by-product thereof.

To summarize the above positively, business schools try to avoid the subjective area of emotions by developing objective decision mechanisms. Put more negatively, business schools educate people to avoid emotions. Their unstated (and perhaps unconscious) aim is to transform their students into nonhumans. This interpretation is by no means a bold hypothesis. A serious study at the renowned Cornell University showed that business majors entering university demonstrated the same level of social behavior as did all other freshman. After graduation, however, business majors showed a distinctly lower level of social behavior.

The study on management versus leadership skills mentioned above was carried out quite some time ago, and I am not aware of a newer one. However, I have no doubt about the result that a newer study would show. I think Germany scores almost identically to the US today. My personal business experience in Germany came between the end of the 1980s and the beginning of this century. It was a typical time of transition. Old leaders retired who had never seen a business school or anything similar from the inside. Typically, they were educated in schools of engineering. They were replaced by highly educated young managers, many of whom had MBAs from renowned schools. The new managers are better in almost any aspect of management. They know ERP systems and are able to calculate and understand fancy financial indicators – about all of which the former leaders had no clue. But the old leaders showed emotions. At times, the subordinates suffered as a result. The relationships were sometimes good and sometimes bad, but at least there were relationships. By contrast, many of the successors show no emotions. They never have bad relationships with their subordinates, but they never have good relationships either. They have no relationships. They are nothing but highly sophisticated workflow management systems.

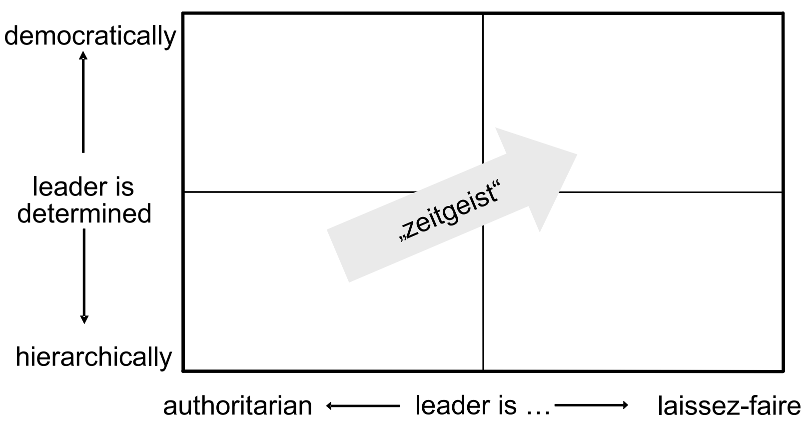
Leadership involves emotions and is therefore a relationship in many ways quite analogous to the personal relationship of a couple. More precisely, in a personal relationship (e.g., between a man and woman) there are three phases, which may occur in parallel: Sexual attraction, being in love, and long-term bonding.[16] The leadership relationship corresponds only to the long-term bonding. Even long-term bonding does not work out well all the time. If differences are not too severe, one may sort out a problem by talking about it -- perhaps with the help of a professional. Not talking to one another is definitely the end of any relationship. All of this applies to business relationships, as well. If a relationship truly fails, then the people have to separate, and it does not make sense to try to judge whose fault it was. It is like a shoe that does not fit well. Is the shoe too small or the foot too big? So, if all coaching fails the leader and subordinates, too, must separate. In leadership, the situation is slightly different from that of a married couple. The leader normally has several subordinates. The relationships may be fine with, say, eight subordinates but fail

[16] Psychologists suggested the three phases already a long time ago. Quite recently, these have been proven scientifically by measuring certain hormone levels and performing NMR brain scans.

completely with two of them. Obviously, these two subordinates should leave their leader. It is a situation quite common in the business world. There are also situations where the relationship between leader and subordinates is fine with two individuals but fails with eight of them. Again, leader and subordinates should separate. In this case, though, the leader should leave. That is the only logical consequence, although it is rarely what happens in reality.

There are very many ways to classify management styles. One is shown in the matrix of Fig. 7-15. The leadership style is plotted on the horizontal axis. It ranges from authoritarian to laissez-faire. The vertical axis displays how the leader is determined. Hierarchically, means being appointed top-down from CEO to middle manager. Democratically means, in the extreme, being elected by the subordinates. This extreme form scarcely exists in reality. However, to elect the head of a country was similarly unusual 500 years ago. In today's business world, subordinates sometimes do have some say in who should lead them. Though I personally was never elected to be a leader, I never wanted to stay a leader if my subordinates would not

Fig. 7-15: *Classification of leadership style*



have elected me had they had the power to do so. In Fig. 7-15, I have indicated that history, or better zeitgeist, implies a move from the lower left corner to the upper right corner. However, it is maybe true for a majority but by no means for all. Subordinates and leaders both have their natural places in the matrix of Fig. 7-15. Minor moves are possible but major ones are scarcely so. I know some people prefer a strong and authoritarian leader, and such people will not be happy with a laissez-faire one. I mentioned above that leader and subordinates must “fit” together. One indicator of fit is when both prefer the same region of the matrix in Fig. 7-15.

To close this chapter I will give four quite practical guidelines on how to lead and what to avoid. They are, in my opinion, logical consequence from the things stated above. I will explain them in detail below.

- The leader must be able to explain the background for those things required of the subordinates, and all that is demanded must have a connection to the general goal of the company.
- The leader must be the role model.
- Honesty implies honesty.
- The problem of an individual is always most important.

Leaders tend to demand certain ways of behaving. Some, for example, require a tidy desk. But just requiring it because the leader works best at a tidy desk is wrong. The leader must accept that his or her subordinates are adults who have their own styles. If, however, customers are showing up in the office from time to time, then the leader has a good reason to demand a tidy desk.

Demanding something and then not doing it oneself is always a poor choice. The leader must be a role model even if a certain behavior is not necessary. So, if the desks must be kept tidy because customers are often present, then the leader must always keep his or her desk tidy even if customers are never in the leader’s office.

Probably every leader demands honesty from subordinates. Some leaders, for example, do not tolerate taking home some office supply even though the subordinates may claim they could use it for working at home. Maybe this leader goes on a business trip, books an extremely expensive hotel, and justifies it by his hard work that requires relaxing. In doing so, he bends the rules so that they fit. Perhaps this is fully valid, but one cannot then expect that the subordinates will obey the rules without some interpretation.

Neglecting the last point above, about the problems of individuals, is from my experience a common mistake, and especially among young leaders. I have deliberatively formulated it in a provocative way. Of course, an individual's problems are not most important compared to the well-being of the entire company. But the point is that, for that individual, they *are* most important. A leader must recognize that and act accordingly. To use a negative example, I remember a former colleague who had spent a couple of years in consulting and then moved into a good (junior) leadership position. After a while, he reported to his former colleagues about his new job. He liked it, in general, but he told stories of some of his subordinates coming to him with *ridiculous* problems. For example, a subordinate did not want to go on a longer business trip because he was afraid his girlfriend would betray him. Now, for some readers this, too, may sound ridiculous. Others may be quite the jealous types and will understand the young man's suffering. Be that as it may, this person *had* a problem and he was very concerned. To regard it as ridiculous is unacceptably disrespectful. A leader not able to really understand such a problem is the wrong one for this person, although he or she may be an excellent leader for other people.

8 Appendices

In these appendices, some parts of the book are explained in greater detail. Reading the appendices is by no means necessary for understanding the content of the book or for managing successfully.

8.1 Appendix SC

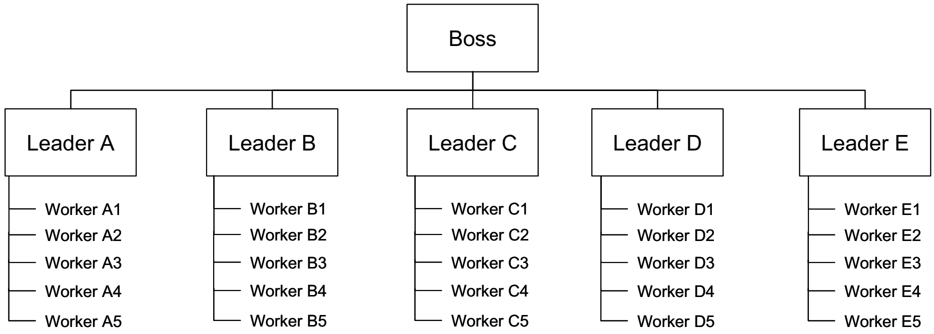
In subchapter 5.4 two things have been presented without proof: The first is the formula connecting the average span of control (<SC>) with the number of managerial positions (M) and the number of people not leading (N). Second is the exponential growth of the workload W_l or W_{ltot}. Both statements will be proven here.

<SC> is connected to M and N via

$$< SC > = \frac{N + M - 1}{M}$$

To prove this formula I will begin with a special organizational chart: Fig. 8-1 shows an organizational chart that is “homogenous.” At every point it has the same span of control SC. Mathematically speaking, SC_i = <SC> for i = 1,…, n. Please note that SC_i = <SC> is not necessarily equal to five as it appears at first glance in Fig. 8-1. Each position (except for the boss) may be a part-time position or occupied by more than one person. Therefore, any span of control may be assumed in Fig. 8-1. (For a span of control of, say, three, every leader A to E must be counted part-time 3/5 = 0.6 of the total. All workers A1 to E5 are also part-time with 9/25 = 0.36 of the total. Non-integer SCs are also possible. Assuming an SC of say 28/5 = 5.6, the leading positions A to E are occupied by 28/25 = 1.12 people each and each worker’s position is

Fig. 8-1: Homogenous organization



occupied by 784/625 = 1.2544 people.) Therefore, the organizational chart of Fig. 8-1 is a homogenous one having any span of control. One may also assume more or less organizational layers (not just three). Assuming L organizational layers the following identity holds:

$$SC^{L-1} = \frac{N}{SC}$$

Both sides of the equation are nothing but the number of units at the lowest level. Applying the logarithm on both sides yields

$$L-1 = \frac{\ln N - \ln SC}{\ln SC}$$

The number of managerial positions M may be obtained by counting M at each layer and summing these. From this we come to

$$M = \sum_{i=0}^{L-1} SC^i$$

Using L – 1 calculated above, gives us

$$M = \sum_{i=0}^{\frac{\ln N - \ln SC}{\ln SC}} SC^i$$

Although this expression looks quite ugly, it is nothing but a geometrical sequence. Its sum is

$$M = \frac{SC^{1+\frac{\ln N - \ln SC}{\ln SC}} - 1}{SC - 1} = \frac{SC^{\frac{\ln N}{\ln SC}} - 1}{SC - 1} = \frac{N - 1}{SC - 1}$$

Now I have proven the formula for a homogenous organization where <SC> = SC_i. To finish the proof, I have to show that any organizational chart can be transformed into a homogeneous one without changing <SC>, M and N. This is easily done by, first, making each layer homogenous and, second, making the layers homogenous with each other. The following example makes it clear. Consider the by now well-known organizational chart of Fig. 5-12. Rearranging the people in the lowest level (here Bob and Michael) will lead to the chart in Fig. 8-2. Each layer has the homogeneous span of control of three or of 2-2/3, respectively. The same trick can be applied between the layers leading to the chart of Fig. 8-3. It leads to an SC of 11/4 everywhere. Note that in reality nobody works negative (e.g., -1/6 Michael). It is just a mathematical trick to prove the formula.

Fig. 8-2: Organizational chart with homogenous layers

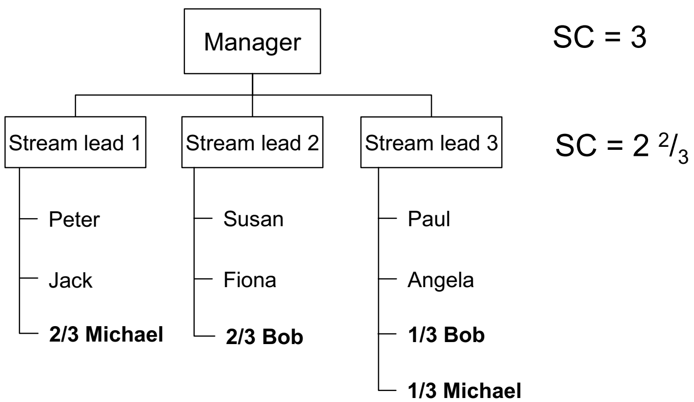
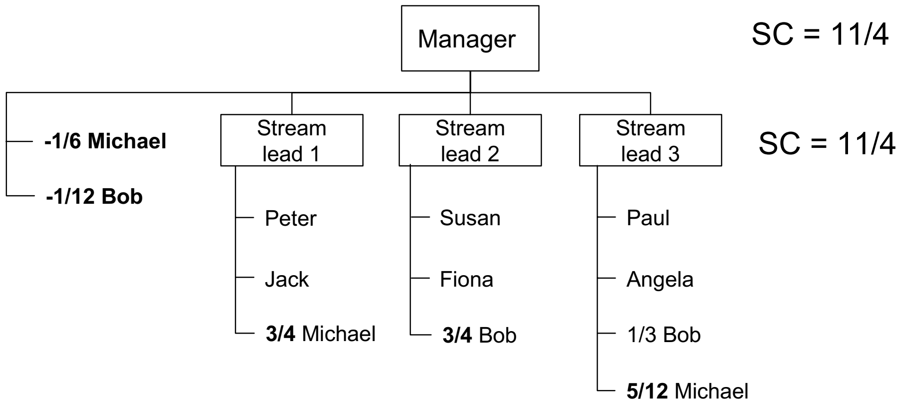


Fig. 8-3: Completely homogeneous organizational chart



So much, then, for the proof. In addition, I promised to show how it leads to the exponential growth (base 2) in the workload for leading people. Conflicts can occur if two or more people interact with each other. Of course, not every contact will lead to a conflict. There is a larger or smaller probability for it. While nobody can calculate this probability, one can conclude that the number of potential contacts is proportional to the number of conflicts. Therefore, we have

$$W_{l\ for\ solving\ conflicts} \propto number\ of\ possible\ groups$$

The number of possible groups is easy to find. SC people can be displayed as follows:

SC:  …

People participating in a group will be marked by "1" and not participating by "0." If, for example, the first, second and fifth people will form one group, then one will have the following picture:

SC:  …

1 1 0 0 1 0 0 0 0 0 …

Every possible group is a binary number. The number of possible groups formed from SC people equals the number of different numbers in a SC-digit binary number. It is equal to 2SC + 1. This number includes the group with nobody in it (all "0"; 1 possibility) and groups with one person only (one "1" only; SC possibilities). These must be subtracted. So we have

$$W_{l\ for\ solving\ \ conflicts} \propto 2^{SC+1} - 1 - SC$$

The "–1" and the "–SC" are contributions to the constant and linear terms, respectively. They can be integrated there. And 2^{SC+1} equals twice 2^{SC}. Therefore, one may write

$$W_l = A + B \cdot SC + C \cdot 2^{SC}$$

Multiplied by all managerial positions

$$M = \frac{N-1}{SC-1}$$

Finally, then, one will reach:

$$W_{ltot} = \frac{N-1}{SC-1}\left(A + B \cdot SC + C \cdot 2^{SC}\right)$$

8.2 Number of vendors

In this part of the appendix, the following formula is derived:

$$NOV = const. \cdot \sqrt{V}$$

NOV is the number of vendors and V the purchasing volume. Let us suppose a company has a certain number of vendors NOV and a purchasing volume V. If it wants to buy something in addition, the firm may find it at an already existing vendor or it may need a new vendor. The probability of finding the item at an existing vendor is proportional to the number of vendors. Therefore, the change in the number of vendors Δ NOV is small if there are already many vendors to choose from. Translated into mathematics, it yields:

$$\Delta NOV \propto {}^{1}\!/_{NOV}$$

This can be written as a differential equation in the following form:

$$\frac{d\,NOV}{dV} = \frac{C}{NOV}$$

(C is a new constant.) This simple differential equation is easily solved by separation of variables. Knowing that V = 0 implies NOV = 0, one can write

$$\int_0^{NOV} d\,NOV' \cdot NOV' = C \int_0^{V} dV'$$

Performing the integration one has

$$NOV^2 = C \cdot V$$

Defining constant ≡ $C^{1/2}$ one finds

$$NOV = constant \cdot \sqrt{V}$$

8.3 Errors

In this part of the appendix, I will consider two quantities with margins of error:

$$a = \langle a \rangle \pm \Delta a \qquad \text{and} \qquad b = \langle b \rangle \pm \Delta b$$

The question is how to add and multiply such quantities. The answer is easily found if one knows how Δa and Δb are defined. There are several definitions for these variations. I prefer to interpret them as the *average quadratic error*. Measuring a at a particular time, one will find the value a_i with

$$a_i = \langle a \rangle + \Delta a_i$$

Δa_i denotes the individual deviation at that time. It is sometimes positive and sometimes negative and

$$\langle \Delta a_i \rangle = 0$$

always holds. A reasonable definition of Δa is

$$\Delta a \equiv \sqrt{\langle \Delta a_i{}^2 \rangle}$$

One may write now

$$a_i + b_j = \langle a \rangle + \Delta a_i + \langle b \rangle + \Delta b_j$$

The terms Δa_i and Δb_j denote the deviation of the sum at a particular time. The square root of their quadratic average is the desired average deviation of the sum. One just has to calculate

$$\sqrt{\langle (\Delta a_i + \Delta b_i)^2 \rangle} = \sqrt{\langle \Delta a_i{}^2 \rangle + 2 \cdot \langle \Delta a_i \Delta b_j \rangle + \langle \Delta b_j{}^2 \rangle}$$

As long as Δa_i and Δb_j are fluctuating independently (uncorrelated errors) the average of Δa_i times Δb_j is zero. Therefore, we have the desired result

$$a+b=\langle a\rangle+\langle b\rangle\pm\sqrt{\Delta a^2+\Delta b^2}$$

If the two errors are correlated, then one fluctuation is always big when the other is big. Therefore, one simply adds the errors and that leads to

$$a+b=\langle a\rangle+\langle b\rangle\pm(|\Delta a|+|\Delta b|)$$

The same procedure can be applied for obtaining the product instead of the sum. In that case, we have

$$a_i\cdot b_j=(\langle a\rangle+\Delta a_i)\cdot(\langle b\rangle+\Delta b_j)=$$
$$=\langle a\rangle\cdot\langle b\rangle+\langle a\rangle\cdot\Delta b_j+\langle b\rangle\cdot\Delta a_i+\Delta a_i\cdot\Delta b_j$$

The last three terms (containing the Δs) comprise the fluctuation of the product. The square root of their quadratic average yields the desired result. There one has to calculate

$$\sqrt{\langle(\langle a\rangle\cdot\Delta b_j+\langle b\rangle\cdot\Delta a_i+\Delta a_i\cdot\Delta b_j)^2\rangle}$$

As long as Δa_i and Δb_j are fluctuating independently (uncorrelated errors), all cross terms will vanish under the average operator. Only the pure quadratic terms will have nonzero averages, and these are easily calculated. Therefore, multiplying two quantities having margins of error yields:

$$a\cdot b=\langle a\rangle\cdot\langle b\rangle\pm\sqrt{\langle a\rangle^2\cdot\Delta b^2+\langle b\rangle^2\cdot\Delta a^2+\Delta a^2\cdot\Delta b^2}$$

If the errors of a and b are correlated, then the cross terms will not vanish and the result is

$$a\cdot b=\langle a\rangle\cdot\langle b\rangle\pm\left(|\langle a\rangle\cdot\Delta b|+|\langle b\rangle\cdot\Delta a|+|\Delta a\cdot\Delta b|\right)$$

8.4 Comment on nonlinear ABC

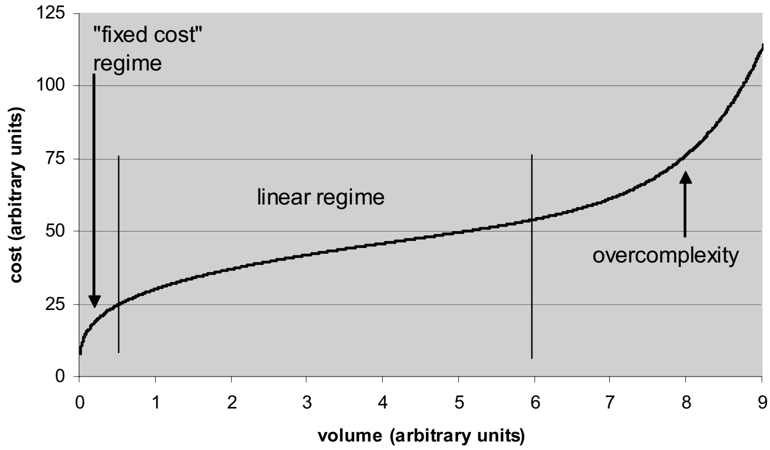
In subchapter 6.3, it was assumed that everything is linear. That is quite often a good approximation, but it is rarely exact and sometimes quite wrong. There are two different sources of nonlinearities when dealing with ABC. I will briefly comment on these here, but I also must remark that beyond the linear world ABC makes hardly any sense in almost any real life situation.

The two sources of nonlinearities are:

- the cost factors
- the process itself

The first source of nonlinearities is relatively easy to deal with. In the linear world, one assumes that cost equals volume times a cost factor (e.g., cost = 150 orders · 100 €/order = €15,000). If the cost is not linear, then one faces a situation where producing, say, 100 pieces does not cost 10 times more than producing 10 pieces. A simple reason for nonlinearity is fixed cost. For example, if a machine is not running at 100% of its capacity its depreciation will be distributed to the number of pieces produced. Therefore, the cost per piece will decrease with volume. Once a machine is running at full capacity, then doubling the volume will double the cost. This is the start of a linear regime. Such a linear regime will not last forever, though, as producing *very* big amounts might become very complex. In this case, cost will most likely increase at a greater-than-linear rate. This phenomenon is sometimes referred to as overcomplexity. A typical cost function is displayed in Fig. 8-4. Of course, one can think of other reasons besides fixed costs or overcomplexity for nonlinearities. The cost for drilling a hole is proportional to the metals thickness and the diameter. However, the cost is a highly nonlinear function of the accuracy. (An accuracy of ±0.001 mm will cost much greater than 10 times more compared to an accuracy of ±0.01 mm. In contrast, going from ±0.1 mm to ±0.01 mm is unlikely to double the cost. In any case of such nonlinearity one has a

Fig. 8-4: *Typical cost function: cost = cost(volume)*



cost function rather than a simple cost factor. Dealing with (nonlinear) cost functions rather than (linear) cost factors does not in and of itself cause a great problem. In most such real-world situations, however, nobody knows the cost function in the form of a mathematical function. (In the case of pure fixed cost nonlinearity, however, the function is known.)

The second point above (nonlinear process) is much trickier. In (linear) ABC each process step produces a certain cost. The sum of all process steps leads to the entire cost. As an example, take the two steps of preparing a bill (€10) and mailing a bill (€1). Preparing and mailing will cost €10 + €1 = €11, but such linear adding is not always correct. Transporting a box from A to B might cost x. Transporting a similar box from B to A will probably also cost x. However, bringing one box from A to B *and* another one from B to A will not necessarily cost 2x. Depending upon the circumstances, it may cost just x. (This would be the case if the single transport would require an empty truck driving back.) The example of transport might look a little bit artificial, but quite often combining two particular activities will save some costs. To see that it will happen is easy, but to calculate the exact amount is next to impossible. Please note that it is also possible that combining two tasks will increase the cost.

To summarize, one can say that nonlinear ABC appears to be sometimes necessary, but performing it in reality is rarely possible. Therefore, one should just check from time to time whether the linear approach is still appropriate. If it is no longer the case, then one most likely has no possibility to perform a reasonable cost calculation any longer. (In addition, chaos might come into play, cf. subchapter 6.5.)

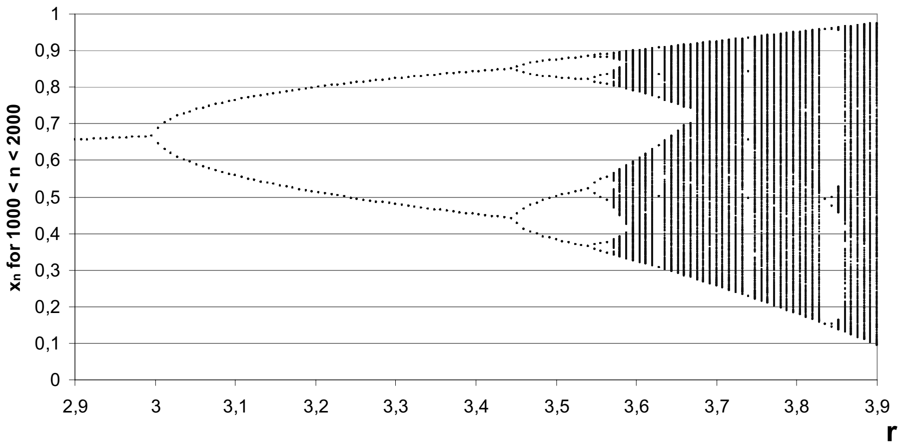
8.5 Logistic map and Liapunov exponent

Mathematicians have tried to find simple situations where chaos is present. One extensively studied example is the so-called logistic map. It has the form

$$x_{n+1} = r \cdot x_n (1 - x_n)$$

r is a parameter. Its magnitude determines whether the logistic map is chaotic or not. In order to see how it works, let us take r = 2.9 for a start. If $x_1 = 0.5$, then one will have $x_2 = 2.9 \cdot 0.5 \cdot (1 - 0.5) = 0.725$. In the same way, one will get $x_3 = 0.5781875\ldots$, $x_4 = 0.70727147\ldots$, and so forth. However, x_{169} is equal to just 0.65517241… All higher iterations of x (e.g., x_{1234}) will remain at this value. This phenomenon has nothing to do with chaos. Rather, 0.65517241… is a fixed point of the logistic map when r = 2.9. (Starting with $x_1 = 0.1$ instead of $x_1 = 0.5$ leads to an almost identical result, except that x_{167} already equals 0.65517241…) The first step towards chaos appears at $3 \leq r \leq 3.444$, wherein the x_i will jump between two points (For r = 3.1, for example, they are 0.558… and 0.764…). The scattering between these two points appears to be almost random. The exact way of scattering strictly depends upon the starting value of x_1. The next surprise starts at r > 3.444…. Now x_i takes four different values. In Fig. 8-5, I have drawn the behavior of the

Fig. 8-5: *Logistic map, onset of chaos*



logistic map for 2.9 ≤ r ≤ 3.9. For r < 3 the behavior is completely fully developed. Please note that objects like the logistic map are not limited to mathematicians only. In planning and forecasting, one quite often uses a formula called exponential smoothing. It takes the form

$$F_{t+1} = F_t + \alpha \cdot (A_t - F_t)$$

(F_{t+1} is the forecast for the time t +1, F_t is the old forecast, and A_t is the actual value of the last period. α is a smoothing factor.) Although the formula (map) for exponential smoothing does not show chaos, slight variations upon it may well do so. Some may object that the formula for exponential smoothing does not contain a nonlinearity, and therefore it cannot show chaotic behavior. However, extensions and alterations of the formula may contain nonlinearities.

In maps such as the logistic map, proving chaos is not just done numerically like in the plot of Fig. 8-5. There are more rigorous definitions. One is the so-called Lyapunov exponent. For its definition, take an initial value x_0 and its (arbitrarily small) variation ε leading to an initial value between x_0 and $x_0 + \varepsilon$. Taking a map of the general form

$$x_{n+1} = f(x_n)$$

leads after N iterations to a value for x_N between

$$f^N(x_0) \qquad \text{and} \qquad f^N(x_0 + \varepsilon)$$

The difference of these two values may be defined as

$$f^N(x_0 + \varepsilon) - f^N(x_0) \equiv \varepsilon \cdot e^{N\lambda(x_0)}$$

where λ is at this stage just a parameter. Dividing both sides by ε and taking the limit $\varepsilon \to 0$ will create a differential quotient. Taking the logarithm of it and the limit $N \to \infty$ leads to the final definition of the Lyapunov exponent

$$\lambda(x_0) = \lim_{N \to \infty} \frac{1}{N} \log \left| \frac{df^N(x_0)}{dx_0} \right|$$

Chaos is given if $\lambda > 0$. From this definition, one sees that chaos means that an initial arbitrarily small disturbance grows exponentially with a positive exponent. This is a reasonable definition. It is in accordance with the sloppy definition given in 6.5.1, where I essentially said that chaos is a situation where arbitrarily small causes have big effects in the end.

8.6 Numerical solution of transcendental equations

In 7.1, there was a problem of solving two equations simultaneously. I will show here how to handle this problem. In a special case, an analytical solution is possible. In addition, I will show a numerical solution for a wide range of parameters. The equations under consideration were:

$$u_1 = u_0 \cdot (e^{p_1/\tau} - 1) \qquad\qquad u_2 = u_0 \cdot (e^{p_2/\tau} - 1)$$

Dividing one by the other leads to

$$\frac{u_2}{u_1} = \frac{e^{p_2/\tau} - 1}{e^{p_1/\tau} - 1}$$

By substituting

$$e^{p_1/\tau} \equiv x \qquad \text{and} \qquad \frac{p_2}{p_1} \equiv q$$

one will find

$$x^q - \frac{u_2}{u_1} \cdot x + \frac{u_2}{u_1} - 1 = 0$$

It looks a bit friendlier now, but it is still a transcendental equation with no analytic solution generally. However, for the special case of q = 2 it becomes a simple quadratic equation. This limitation is less severe than it looks. In business, one might easily find two planning periods with a ratio of q = 2 (e.g., 6 months and 1 year). The solution for q = 2 is

$$x = \frac{u_2}{u_1} - 1$$

Re-substituting the values from above, one comes to

$$\tau = \frac{p_1}{\ln\left(\frac{u_2 - u_1}{u_1}\right)} \qquad u_0 = \frac{u_1^{\ 2}}{u_2 - 3 \cdot u_1}$$

Please note that p_2 does not appear in this solution. In this special case, $p_2 = 2 \cdot p_1$ always holds by definition.

Analytical solutions are also possible for q = 3, q = 4, q = ½, q = ⅓, and q = ¼. With the exception of q = ½, however, they look horribly complicated (and q = ½ is identical to q = 2.) Every other case requires a numerical solution. Their results are displayed in Fig. 8-6 and Fig. 8-7. The ratio u_2/u_1 is shown on the horizontal axis. The vertical axis displays $\exp(p_1/\tau)$ (formerly known as x). The different curves represent various values of the ratio p_2/p_1. For $p_2/p_1 = 2$, one will find a straight line in Fig. 8-7. It represents the simple analytic solution stated above. To solve a given problem is now quite simple. As an example, take the problem from 7.1. There, we had p_1 = 3 months and p_2= 1 year (or q = 4), u_1 = 1% and u_2 = 5%. So, one should go to Fig. 8-7 where the curve for q = 4 has been plotted. For $u_2/u_1 = 5$, one finds $\exp(p_1/\tau) = 1.15$ (the exact number is 1.1509110844). From it, one finds τ = 3 months/ln(1.1509110844) = 649.21 days. Inserting the value for $\exp(p_1/\tau)$ into the original equation, one finds u_0 = 1%/(1.1509110844 – 1) = 6.6264%.

Fig. 8-6: *Solution for u_0 and τ for $q = 1.1$ to $q = 1.9$*

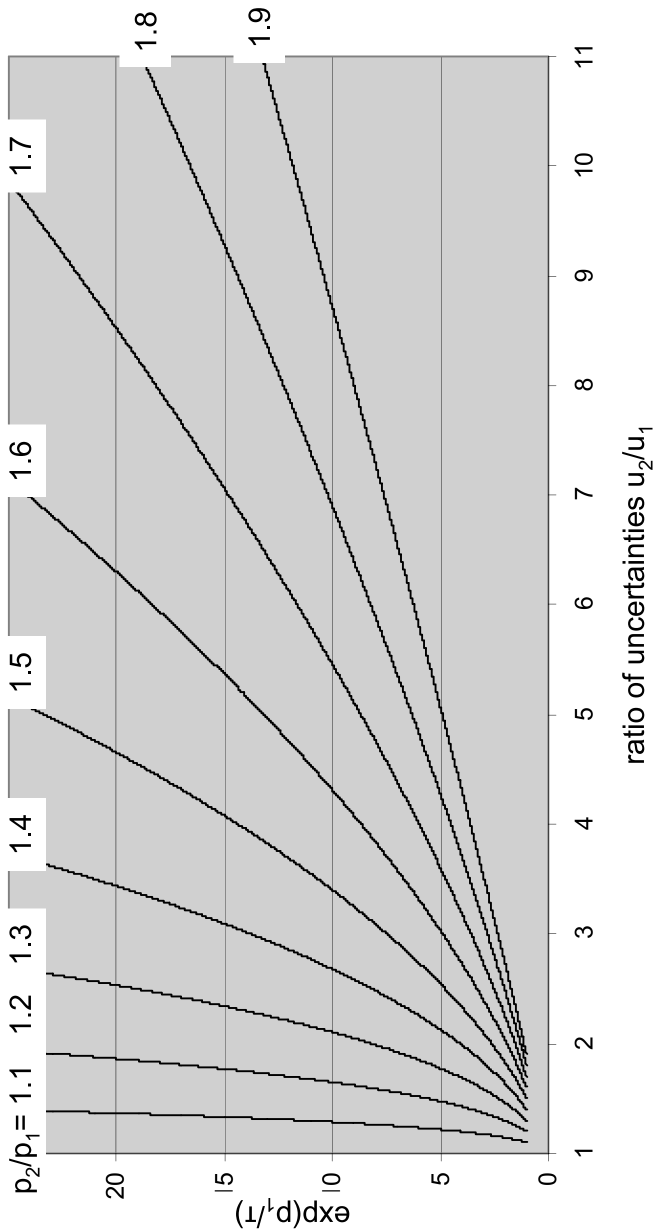
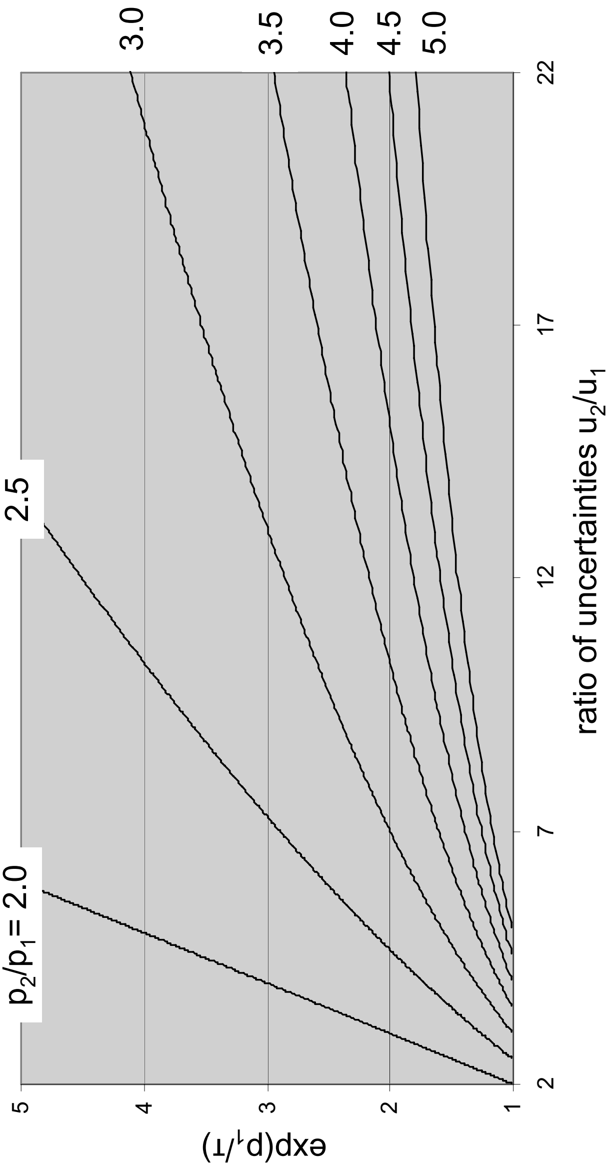


Fig. 8-7: *Solution for u₀ and τ for q = 2 to q = 5*



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