Chapter 8
Process Redesign

We know what we are, but not what we may be.
William Shakespeare (1564–1616)

The thorough analysis of a business process typically sparks various ideas and directions for redesign. The problem is, however, that redesign is often not approached in a systematic way, but rather considered as a purely creative activity. The critical point with creative techniques is that parts of the spectrum of potential redesign options could be missed. As an alternative, suitable methods can be utilized to yield more and, hopefully, better redesign options.

This chapter deals with rethinking and re-organizing business processes with the specific purpose of making them perform better. We clarify the motivation and the trade-offs of redesign. Then, we present two methods for systematically redesigning processes. First, we introduce Heuristic Process Redesign as a method that builds upon an extensive set of redesign options. The method is illustrated by the help of a case of a health care institute. Second, we present Product-based Design. This method derives a process design based on the composition of a product.

8.1 The Essence of Process Redesign

In this section, we describe the motivations and the trade-offs of redesign. We introduce the Devil's Quadrangle and discuss options of how redesign can be approached.

8.1.1 Why Redesign?

As stated, the focus of this chapter is on how to redesign business processes. Before explaining this, it is good to reflect on why again it is beneficial at all to focus on business processes. Recall that a business process creates and delivers a certain product or service that customers are after. If someone would like to improve the quality of such a product or service from the perspective of a customer, arguably

M. Dumas et al., *Fundamentals of Business Process Management*,
DOI 10.1007/978-3-642-33143-5_8, © Springer-Verlag Berlin Heidelberg 2013

the best way to do that is to improve the related business process. For example, if at some point clients like to make use of a service they purchase from a company much earlier than it is able to deliver, it makes sense to think of streamlining the business process in question. In that way, a *customer-oriented* organization is in fact a *process-centered* organization. Business process redesign is all about improving the quality of products and services by rethinking and re-organizing business processes.

Question Why would anyone like to *redesign* business processes?

One could argue that if a business process has been designed well in the first place, then the products and services are already produced in a satisfactory way. Indeed, if you can step into a bank or a governmental agency, you can see processes in action in ways very similar to how they were introduced there some 50 years ago. This is not necessarily a good thing, though. There are at least two reasons why it makes sense to consider the redesign of an existing business process, even when it was perfectly designed in the first place. The first of these relates to the *organic nature* of organizations. All business processes tend to evolve organically over time. As a result, they grow more complex and their performance gradually deteriorates. Some common examples of such situations are as follows:

- At some point, a clerk forgets to carry out a particular quality check. The product was delivered to a client who became really upset because of the unnoticed flaws of the product. In response, an extra check is incorporated which involves a second clerk to check out whether the quality check is performed at all. This works quite well, but after some time the initial quality check becomes automated through the introduction of a new production system. The check-on-the-check becomes superfluous, but is still part of the process, in this way consuming unnecessary resources and time.
- The marketing department of an organization introduces a special offer for a particular type of customers. Each time such a customer engages with this organization, their account managers ask for extra information beyond what is normally asked. In this way, the marketing campaign can make a perfectly targeted offer to these customers. Yet, the information is not really necessary for the services the clients contact this organization in the first place. After some time, the marketing campaign has come to and end, but the account managers will still ask for the extra information whenever they interact with the particular kind of customer: an unnecessary and time-consuming step.
- An internal auditing department demands at some point that the monetary value of certain financial activities are always reported to it, whenever such activities are carried out. This cause an extra calculation and an extra reporting step in each of the business processes that are affected. Over time, the management of the auditing department changes its priorities and starts looking into other, non-financial information. The reports, nonetheless, keep coming in.

None of the above examples seem so difficult that they cannot be overcome, of course. The point is that people who are busy with carrying out day-to-day operations are usually neither inclined nor equipped to start rethinking the overall structure of operations within an organization. Specifically, it is very common for people to have a limited insight into why a business process is organized in the way it is: People know how to perform their own activities, perhaps some of the activities up- and downstream from their position in the process, but certainly not much more. Even managers, of whom it can be expected that they take a "helicopter view", are usually more concerned with day-to-day execution than structural improvement. People, it seems, are creatures of habit. A business process perspective helps to overcome the inhibition to improve. So, to fight the troubles that go hand in hand with the organical development of a process, redesign is a good idea.

Another reason why it is worthwhile to redesign a business process, even a process that was perfect when it was designed in the first place, is that the *world evolves* as well. New competitors enter the market place that can deliver the same product or service that you can, but against lower cost or tailored to a customer's specific needs. The preferences of customers may change too: People may have been willing to pay a premium for your high-quality product for a long time, but they may now prefer a similar product of lower quality that is offered against a considerably lower price. Whether it is sensible for an organization to keep on producing a certain product or service is not within the scope of this book; that is much more of a strategic decision. What we care about are the operations of an organization. So, assuming there is a strategic incentive to keep on offering a product or service, business process redesign is the approach to create and deliver it in a more performative way.

Exercise 8.1 Can you identify business processes from your own experience that may perhaps have been competitive at some stage, but which seem at this point to be unnecessarily complex or outdated given what competitors offer?

While the two reasons we discussed are important to consider redesigning an existing process, the principles behind redesign approaches can also be helpful to develop business processes from scratch. For example, in 2002 the Netherlands Authority for the Financial Markets was set up to regulate behavior on the Dutch financial markets. Many of the business processes it had to start executing had to be newly developed. Process redesign principles were applied to find the right balance between effectiveness and efficiency. We will still refer to such occasions as process redesign, even though it is technically a misnomer—we would be more precise when referring to this situation as process *design*. We will return to this issue of developing processes from scratch when we will be discussing the various types of redesign approach.

8.1.2 What Is Redesign?

Let us now take a closer look at what redesign is. If you would follow a broad interpretation, any change to an existing process, minor or major, qualifies. Since business processes are rather encompassing—they concern among other the steps in a process, the workforce that is committed to carrying out the process, the information that is being exchanged, and the information systems employed—this actually seems to cover quite a lot. When we talk about process redesign in the context of this book, we will not refer to casual or minor updates, or to changes of parts peripheral to a process or that have no relation to the business process concept. For example, let us suppose that a bank prints the conditions under which a mortgage is granted on ordinary paper, and is accustomed to sending the paper work to applicants when the conditions are completely settled and approved. If the paper type is changed into an eco-friendly, recycled alternative, then we would not consider this as an act of process redesign. If, on the other hand, the client would be provided at any time with an insight into an electronic file that shows the conditions as they are developed during the execution of the process, we would be much more confident in calling this process redesign, especially if the idea behind it is to improve the customer's experience.

Rather than trying to pinpoint business process redesign to an exact definition, we present a framework that helps to think and reason about the most important manifestations of this approach. In this framework, seven elements are identified:

1. the internal or external *customers* of the business process
2. the *business process operation* view, which relates to how a business process is implemented, specifically the number of activities that are identified in the process and the nature of each, and
3. the *business process behavior* view, which relates to the way a business process is executed, specifically the order in which activities are executed and how these are scheduled and assigned for execution
4. the *organization* and the participants in the business process, captured at two levels: the organization structure (elements: roles, users, groups, departments, etc.), and the organization population (individuals: agents which can have activities assigned for execution and the relationships between them)
5. the *information* that the business process uses or creates
6. the *technology* the business process uses, and
7. the *external environment* the process is situated in

Process redesign, then, is first of all concerned with changing the business process itself, covering both its operational and behaviorial view. Yet, process redesign extends to changes that are on the interplay between on the one hand process and on the other the organization or even the external environment that the process operates in, the information and technology it employs, as well as the products it delivers to its customers. This is a comprehensive way of looking at process redesign but it does exclude some activities. For example, the way to train people to optimally perform new activities they become responsible for is out of scope.

Exercise 8.2 Consider the following list and indicate which of these you would consider as process redesign initiatives. Motivate your answer and, if applicable, provide the links to the elements discussed.

1. An airline has seen its profits falling over the past year. It decides start a marketing campaign among its corporate clients in the hope that it can extend its profitable freight business.
2. A governmental agency notices that it is structurally late to respond to citizen's queries. It decides to assign a manager to oversee this particular process and mandates her to take appropriate counter actions.
3. A video rental company sees that its customer base is evaporating. It decides to switch to the business of promoting and selling electronic services through which clients can see movies on-line and on-demand.
4. A bank notices internal conflicts between two different departments over the way mortgage applications are dealt with. It decides to analyze the role of the various departments in the way applications are received and handled to come up with a new role structure.
5. A clinic wants to introduce the one-stop-shop concept to improve over the situation that its patients need to make separate appointments for the various diagnostic tests that are part of a procedure for skin cancer screening.

Not each business domain is equally suitable for the application of business process redesign. To appreciate this, consider the differences between the manufacturing and services domain. In the *manufacturing domain*, the emphasis is on transforming raw materials into tangible products, which often relies on the use of robots and sophisticated machinery. It is in the *services domain* where mostly knowledge is involved in the processing of information to deliver a particular service. Compare, for example, a car manufacturing company with an insurance company as two characteristic examples of the respective domains. In general, it is fair to say that for service organizations the following properties hold:

- Making a copy is easy and cheap. In contrast to making a copy of a product like a car, it is relatively easy to copy a piece of information, especially if the information is in electronic form.
- There are no real limitations with respect to the in-process inventory. Informational products do not require much space and are easy to access, especially if they are stored in a database.
- There are less requirements with respect to the order in which activities are executed: Human resources are flexible in comparison with machines; there are few technical constraints with respect to the lay-out of the service process.
- Quality is difficult to measure. Criteria to assess the quality of a service, an informational product, are usually less explicit than those in a manufacturing environment.
- Quality of end products may vary. A manufacturer of goods usually has a minimal number of components that any product should incorporate. However, in the services domain it might be attractive to skip certain checks in producing the informational product to reduce the workload.

- Transportation of electronic data is timeless. In a computer network, information travels almost at the speed of light; in a manufacturing environment, the transportation of parts is an essential share of the total lead-time, for example think of parts and sub-assemblies that have to be moved from one plant to the other.

From these differences, it is clear that there are more degrees of freedom for redesigning business process in the services domain, than is the case in the manufacturing domain. To optimize a manufacturing process, one has to look for opportunities while juggling many physical constraints. For example, parts that have to be assembled must be transported to the same physical location; by contrast, pieces of information can be put together while they are physically stored on different locations. Similarly, where logistics has evolved as a field to deal with the inventory of parts and half-products, the storage of (digital) information is usually a *no-brainer*. Business process redesign, therefore, is at this point mostly applicable in the services domain. Since there is a trend that manufacturing and high-tech organizations are increasingly making money with providing services along with their physical products, it can be expected that process redesign will become of greater importance here as well.

Exercise 8.3 Consider the following processes and decide whether they are suitable for being redesigned. Use the properties that distinguish the manufacturing and services domain as a mental checklist to support your choice.

1. Dealing with a customer complaint.
2. Carrying out cardiovascular surgery.
3. The production of a wafer stepping machine.
4. Transporting a package.
5. Providing financial advice on composing a portfolio.
6. Designing a train station.

8.1.3 The Devil's Quadrangle

So far, we have not been overly specific about the goals behind redesign. Clearly, it is about making a business process perform better, but we have not discussed the available directions for improvement.

Question What do we want to achieve exactly when a process is redesigned?

A framework that helps answering this question is the *Devil's Quadrangle*, which is depicted in Fig. 8.1. This framework is based on the four performance dimensions discussed in Chap. 7, namely time, cost, quality and flexibility. Ideally, a business process redesign *decreases* the time required to handle a case, it lowers the required cost of executing the process, it *improves* the quality of the service delivered, and

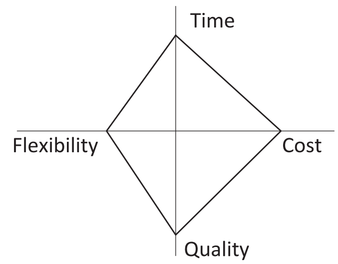


Fig. 8.1 The Devil's Quadrangle

it *increases* the ability of the business process to deal with variation. The interesting property of this framework is how it expresses that improving a process in one dimension may have a weakening effect on another. For example, one may decide to add a reconciliation activity to a business process to improve the quality of the delivered service. Yet, this may backfire on the timeliness of the service delivery. The ominous name of the framework refers to the difficult trade-offs that sometimes have to be made. Awareness of these trade-offs is utterly important for effective process redesign.

Exercise 8.4 Consider the following redesign acts. Which performance measures are affected by these, either positively or negatively?

1. A new computer application is developed that speeds up the calculation of the maximum loan amount that a given client can be offered.
2. Whenever a quote is needed from a financial provider, a clerk must use a direct messaging system instead of e-mail.
3. By the end of the year, additional, temporary workers are hired and assigned to picking items for fulfilling Christmas orders.

While the performance dimensions of the Devil's Quadrangle are helpful to think of the desired effects of business process redesign in general and for a particular business process in particular, they are also useful to think about common approaches to improve business processes. We will devote more attention to this topic when dealing with different types of process redesign approach; we will then refer to them as *redesign heuristics*.

8.1.4 How to Redesign?

There is a great variety of books on process redesign. These deal, among other topics, with different methodologies, present case studies, advance success factors and management lessons. Since the supply may be a bit overwhelming, the following classification may help to see the forest for the trees.

There are three levels of abstractions for methods with respect to process redesign: methodologies, techniques, and tools.

A *methodology*, the highest level of abstraction, is defined as a collection of problem-solving methods governed by a set of principles and a common philosophy for solving targeted problems. This is primarily the field of consulting firms which developed proprietary methodologies, which stretch out from the early analysis phase of a redesign project until the implementation and after care.

At the next level of abstraction, a *technique* is defined as a set of precisely described procedures for achieving a standard task. Some oft-encountered techniques for process analysis—one of the phases in a redesign project—are e.g., fishbone diagramming, Pareto analysis, and cognitive mapping (see Chap. 6). To support the activity of redesigning, creativity techniques like out-of-box-thinking, affinity diagramming, and the Delphi method (brainstorm) are available. For the modeling and evaluation of business processes, techniques are in use as flowcharting, IDEF, speech act modeling, data modeling, activity-based costing, time motion studies, Petri nets, role-playing, and simulation.

At the lowest, most concrete level a *tool* is defined as a computer software package to support one or more techniques. The majority of what some would call process redesign tools are actually process modeling tools. A large number of tools is also available for the evaluation of business process models, in particular supporting the technique of simulation (see Chap. 7). Fewer tools are available to structurally capture knowledge about the redesign directions or to support existing creativity techniques. Tools are often presented as "intelligent" or "advanced", although hardly any of those actively design business processes.

Our concern in this chapter is foremost with redesign methodologies. Now, if you would take the effort to consider all the existing ones you will find that they are usually very specific about preliminary steps in a process redesign project, e.g. the assembly of the project team, and similarly specific towards the end, e.g. how to evaluate a new business process. They are not specific, however, on *how* to take an existing process and turn it into a better performing one. In other words, the *technical challenge* of process redesign is an underdeveloped area. An apt observation that we encountered on this phenomenon is provided by Alec Sharp and Patrick McDermott:

> How to get from the as-is to the to-be [in a process redesign project] isn't explained, so we conclude that during the break, the famous *ATAMO procedure* is invoked ("And Then, A Miracle occurs").

This part of the chapter provides concrete guidance for the technical challenge of process redesign. The two methodologies that we will describe are rather different. To see what distinguishes them it is important to understand the generic traits of process redesign methodologies. Generally speaking, such methodologies can differ with respect to their intensity and their starting point.

The *intensity* of a methodology refers to the pace that one aims with changing the process. Here, we can distinguish between what are commonly referred to as revolutionary and evolutionary levels. Process redesign was originally positioned as an approach that would aim for a radically different outcome, in other words: a revolution. However, methodologies that aim for a more incremental approach have become much more popular. The latter kind would, obviously, qualify as aiming for an evolutionary intensity.

The other distinguishing point is the *starting point* of the redesign effort. One can (a) start from scratch, (b) from the traits of the existing process that is to be redesigned, or (c) from a good, general design, also known as a *reference model*. We will deal with these one by one.

Option (a): Historically, process redesign would follow a *clean slate* approach: the existing process would be completely abandoned and new ways of producing a particular product or service would be developed. It is for good reason that Michael Hammer, one of the gurus behind process redesign famously quipped: "Obliterate, don't automate." There are certain advantages to such an approach: It is much easier to get rid off the inefficiencies that have crept into the process by organic growth (see our earlier discussion). Also, the potential to come up with some truly innovative process alternative is in this way better exploited.

Option (b): Over the course of time, however, it has become a far more popular approach to closely look at the existing process. The reason behind this is that it turned out to be extremely hard to develop a complete process from scratch, in particular to cover all exceptions, to not forget any steps, and to add the required level of detail.

Option (c): The newest development is to start work from a *blueprint* or *reference model*. Such standard solutions are typically developed by consultancy and IT companies as representing the state-of-the-art on how to do purchasing, hire someone, or deal with complaints. The *IT infrastructure library (ITIL)* is a good example of such a solution, as it incorporates practical guidelines on how to do problem and incident management within service organizations. The promise of starting from a blueprint is that it will give an up-to-date and standardized view on how to carry out a business process.

Overseeing the landscape of process redesign methodologies, it is fair to say that using the existing process as a starting point has become at this point the most popular approach, followed by the use of a reference model. Building on either the existing design or a reference design, local updates are then identified, each of which contribute a gradual improvement of performance in comparison with the starting situation. Radical approaches are still being applied. In general, clean sheet, revolutionary approaches tend to be more risky as they break away from existing, known procedures. Yet, they also tend to deliver higher benefits *if* they succeed. After all, inefficiencies can be completely rooted out.

In the remainder of this chapter, we will deal with two different methodologies, which represent two extreme variants of the spectrum. First of all, we will discuss a methodology that is based on so-called redesign heuristics, which starts from an existing process to achieve gradual performance improvement. The second methodology is called Product-Based Design; this approach starts from a blank sheet of paper to come up with a radically improved process design. The two methods will give a fairly good idea of mainstream process redesign and at the same demonstrate how redesign methodologies can fundamentally differ.

8.2 Heuristic Process Redesign

We will now discuss the main stages in the methodology of *Heuristic Process Redesign*. Since there is an overlap between the activities that have been described in other chapters, we will focus on the technical challenge of generating a new process design and provide pointers to other parts of the book here. We will first outline the stages and then turn to its most important ingredient in more detail, i.e. the redesign heuristics that we mentioned earlier.

1. *Initiate*: In the first stage, the redesign project is set up. There are various organizational measures that have to be taken, e.g. setting up the project team, but from a technical perspective the most important goals are: (a) to create an understanding of the existing situation (as-is) and (b) to set the performance goals for the redesign project. For (a), the modeling techniques that have been discussed in Chaps. 3 and 4 are useful, as well as the analysis techniques explained in Chaps. 6 and 7 to gain an understanding of performance issues, bottlenecks, and improvement opportunities. To come up with a clearer picture on (b), the Devil's Quadrangle that has been discussed in this chapter is a great asset.
2. *Design*: Given the outcomes of the initiate stage, the design stage makes use of a fixed list of redesign heuristics to determine potential improvement actions on the existing process. For each of the heuristics that is being considered, it needs to be determined whether it is at all applicable and, if so, what a desirable action is. A redesign heuristics is desirable to apply if it helps to attain the desired performance improvement of the process under consideration. After consideration of each of the redesign heuristics, it makes sense to see which clusters of applicable and desirable heuristics can be created. While for some of the heuristics it may make sense to be applied together, for others this is not the case. For example, if you decide to automate a certain activity, it makes no sense to empower the resource that initially carried out that activity. In this way, a set of scenarios can be generated, each of which describes which redesign heuristics are applied in this scenario and, very importantly, how this is done. For example, if the heuristic to automate an activity is applied it needs to be specified which activities are subjected to it. The scenarios, therefore, should be seen as *alternatives* for the process redesign.
3. *Evaluate*: This is the stage where the different redesign scenarios as developed in the previous stage need to be evaluated. This evaluation can be done in a qualitative way, e.g. employing the techniques from Chap. 6, or in a quantitative way, see Chap. 7. In many practical settings, a combination of the two is used where a panel of experts assesses the attractiveness of the various scenarios and where simulation studies are used to underpin the choice for one particular scenario to develop further, potentially all the way to implementing it. An outcome of the evaluation stage may also be that none of the scenarios seems attractive to pursue or even powerful enough to establish the desirable performance improvement. Depending on the exact outcome, the decision may be to adjust the performance goals, to step back to the design stage, or to drop the redesign project altogether.

The description of the stages are here described as separate ones, but in practice they will be executed in highly iterative and overlapping ways. We will now focus the discussion of the methodology to the *redesign heuristics*. A redesign heuristic can be seen as a rule of thumb for deriving a different process. Many of the heuristics we present suggest a particular action to take, while others merely indicate the dimension along which a business process can be changed. The heuristics we present here are all based on historic redesign projects, where they were applied successfully to generate redesign scenarios.

We explained that improving a process is related to the elements we described in Sect. 8.1.2. Thus, we classify the redesign heuristics in a similar way. We identify redesign heuristics that are oriented towards the seven elements we discussed above: customers, business process operation, business process behavior, organization, information, technology, and external environment. Note that this distinction is not mutually exclusive. Therefore, some redesign heuristics could actually be assigned to more than one of these classes.

8.2.1 Customer Heuristics

Heuristics in this category focus on improving the interaction with customers. They focus on control relocation, contact reduction, and integration.

Control relocation: "Move controls towards the customer". Different checks and reconciliation operations that are part of a business process may be moved towards the customer. Consider the example of Pacific Bell that moved its billing controls towards its customers, in this way eliminating the bulk of its billing errors. It also improved customer satisfaction. A disadvantage of moving a control towards a customer is higher probability of fraud, resulting in less yield.

Contact reduction: "Reduce the number of contacts with customers and third parties". The exchange of information with a customer or third party is always time-consuming. Especially when information exchanges take place by regular mail, substantial wait times may be involved. Also, each contact introduces the possibility of an error injection. Imagine a situation where the multitude of bills, invoices, and receipts creates a heavy reconciliation burden. Reducing the number of contacts may in such a case decrease throughput time. Note that it is not always necessary to skip certain information exchanges, but that it is possible to combine them with limited extra cost. A disadvantage of a smaller number of contacts might be the loss of essential information, which is a quality issue. Combining contacts may result in the delivery or receipt of too many data, which involves cost.

Integration: "Consider the integration with a business process of the customer or a supplier". This heuristic can be seen as exploiting the supply-chain concept known from production. The actual application of this heuristic may take on different forms. For example, when two parties have to agree upon a product they jointly produce, it may be more efficient to perform several intermediate

Table 8.1 Characteristics of the customer heuristics

	Time	Cost	Quality	Flexibility
Control relocation	·	−	+	·
Contact reduction	+	−	+	·
Integration	+	+	·	−

reviews than performing one large review after both parties have completed their parts. In general, integrated business processes should render a more efficient execution, both from a time and cost perspective. The drawback of integration is that mutual dependence grows and therefore, flexibility may decrease.

Using the dimensions of the Devil's Quadrangle introduced earlier, a summary of the general effects of the three customer heuristics is shown in Table 8.1. This table shows that a heuristic can be generally expected to have a positive effect (+), a negative effect (−) or a neutral effect (·) on any of the dimensions of the Devil's Quadrangle. Note that a *positive* effect on the cost dimension, as can be expected from the Integration heuristic, means that cost actually goes *down*.

Exercise 8.5 Explain the + sign for the contact reduction heuristic with respect to the time dimension.

8.2.2 Business Process Operation Heuristics

Business process operation puts the focus on the elements of a business process. There are five heuristics relating to case types: activity elimination, case-based work, triage, and activity composition.

Case types: "Determine whether activities are related to the same type of case and, if necessary, distinguish new business processes". One should be cautious of parts of business processes that are not specific for the business process they are part of. Ignoring this phenomenon may result in a less effective management of such a *subflow* and a lower efficiency. Applying this heuristic may result in faster processing times and less cost. Yet, it may also result in more coordination problems between the business process (quality) and less possibilities for rearranging the business process as a whole (flexibility).

Activity elimination: "Eliminate unnecessary activities from a business process". A common way of regarding an activity as unnecessary is when it adds no value from a customer's point of view. Typically, control activities in a business process do not do this; they are incorporated in the model to fix problems created (or not elevated) in earlier steps. Control activities can often be identified by iterations in a process. The redundancy of an activity can also trigger activity elimination. The aims of this heuristic is to increase the speed of processing and to reduce the cost of handling an order. An important drawback may be that the quality of the service deteriorates.

Table 8.2 Characteristics of the business process operation heuristics

	Time	Cost	Quality	Flexibility
Case types	+	+	−	−
Activity elimination	+	+	−	·
Case-based work	+	−	·	·
Triage	·	−	+	−
Activity composition	+	+	·	−

Case-based work: "Consider removing batch-processing and periodic activities from a business process". Some notable examples of disturbances in handling a single case are (a) that the case becomes piled up in a batch and (b) that the case is slowed down by periodic activities, e.g. because processing depends on a computer system that is only available at specific times. Getting rid of these constraints may significantly speed up the handling of individual cases. On the other hand, efficiencies of scale can be reached by batch processing which are reversed by this heuristic. Also, the cost of making information systems permanently available may be costly.

Triage: "Consider the division of a general activity into two or more alternative activities". Through this heuristic, it is possible to design activities that are better aligned with the capabilities of resources and the characteristics of the cases being processed, which improves quality. On the other hand, specialization in general makes a process less flexible and may decrease the efficiency of work. An alternative form of the triage heuristic is to divide an activity into similar instead of alternative activities for different subcategories of the cases being processed. For example, a special cash desk may be set up for customers with an expected low processing time. Note that the triage heuristic can be seen as a translation of the case types heuristic on an activity level.

Activity composition: "Combine small activities into composite activities and divide large activities into workable smaller activities". Composing larger activities should result in the reduction of setup times, i.e., the time that is spent by a resource to become familiar with the specifics of a case. By executing a large activity which used to consist of several smaller ones, a positive effect may also be expected on the quality of the delivered work. On the other hand, making activities too large may result in (a) smaller run-time flexibility and (b) lower quality as activities become unworkable. Both effects are exactly countered by dividing activities into smaller ones. Obviously, smaller activities may also result in longer set-up times. This heuristic is related to the triage heuristic in the sense that they both are concerned with the division and combination of activities.

The assessment of the heuristics that aim at the business process operation is summarized in Table 8.2. The meaning of the signs is the same as in the previous table. For example, case-based work can be expected to be highly beneficial in the time dimension; triage may boost the quality of a process. Note that only one manifestation of the activity composition heuristic is shown, i.e. the case that large activities are composed of smaller ones.

8.2.3 Business Process Behavior Heuristics

Business process behavior regulates the logic within the business process. There are four heuristics for this category, namely resequencing, parallelism, knock-out, and exception.

Resequencing: "Move activities to more appropriate places". In existing business processes, actual activity orderings often do not reveal the necessary dependencies between activities. Sometimes it is better to postpone an activity if it is not required for its immediate follow-up activities. The benefit would be that perhaps its execution may prove to become superfluous, which saves cost. Also, an activity may be moved into the proximity of a similar activity, in this way diminishing set-up times. This heuristic is also known as process order optimization.

Parallelism: "Consider whether activities may be executed in parallel". The obvious effect of placing activities in parallel is that throughput time may be considerably reduced. The applicability of this heuristic in business process redesign is large. In practical settings, activities are often ordered sequentially without the existence of hard logical restrictions prescribing such an order. A drawback of introducing more parallelism in a business process that incorporates possibilities of knock-outs is that the cost of business process execution may increase. Also, the management of business processes with concurrent behavior can become more complex (flexibility).

Knock-out: "Order knock-outs in an increasing order of effort and in a decreasing order of termination probability". A typical element of a business process is the subsequent checking of various conditions that must be satisfied to deliver a positive end result. Any condition that is not met may lead to a termination of that part of the business process: the *knock-out*. If there is freedom in choosing the order in which the various conditions are checked, the condition that has the most favorable ratio of expected knock-out probability versus the expected effort to check the condition should be pursued. Next, the second best condition, and so forth. This way of ordering checks yields on average the least costly business process execution. Implementing this heuristic may result in a (part of a) business process that takes a longer throughput time than a full parallel checking of all conditions. The knock-out heuristic is a specific form of the resequencing heuristic.

Exception: "Design business processes for typical cases and isolate exceptional cases from the normal flow". Exceptions may seriously disturb normal operations. An exception will require workers to get acquainted with the specifics of the exception even though they may not be able to handle it. Setup times are then wasted. Isolating exceptions may possibly increase the overall performance as specific expertise can be build up by workers working on the exceptions, even though this may come at a cost. A drawback is that the business process will become more complex, possibly decreasing its flexibility.

The assessment of the heuristics that target the behavior of the business process can be seen in Table 8.3. Again, the meaning of the signs is similar to those in

Table 8.3 Characteristics of the business process behavior heuristics

	Time	Cost	Quality	Flexibility
Resequencing	+	+	·	·
Parallelism	+	−	·	−
Knock-out	−	+	·	·
Exception	+	−	+	−

earlier tables. Note how the exception heuristic stands out with respect to improving the quality dimension.

8.2.4 Organization Heuristics

Organization refers to two categories of heuristics. The first set relates to the *structure* of the organization (mostly the allocation of resources). There are seven heuristics in this category, namely case assignment, flexible assignment, centralization, split responsibilities, customer teams, numerical involvement, and case manager.

Case assignment: "Let workers perform as many steps as possible for single cases". By using case assignment in the most extreme form, for each activity execution the participant is selected who has worked on the case before—if any. The obvious advantage of this heuristic is that this person will have become acquainted with the case and will need less set-up time in carrying out subsequent activities. An additional benefit may be that the quality of service is increased: the participant knows exactly what the specifics of the case are. On the negative side, the flexibility of work allocation is seriously reduced. The execution of a case may experience substantial queue time when the person to whom it is assigned is not available, nullifying expected time gains.

Flexible assignment: "Assign work in such a way that maximal flexibility is preserved for the near future". Suppose that an activity can be executed by either of two available participants, then the heuristic suggests to assign it to the most specialized person. In this way, the likelihood to commit the free, more general resource to another work package is maximal. The advantage of this heuristic is that an organization stays flexible with respect to assigning work and that overall queueing time is reduced: it is less probable that the execution of a case has to wait for the availability of a specific resource. Another advantage is that the workers with the highest specialization can be expected to take on most of the work, which may result in a higher quality. The disadvantages of applying this heuristic can be subtle. For example, work load may become unbalanced, resulting in less job satisfaction. Also, possibilities for specialists to evolve into generalists are reduced. These are both quality concerns. In certain situations, specialists may even be more expensive to carry out work.

Centralization: "Treat geographically dispersed resources as if they are centralized". This heuristic is explicitly aimed at exploiting the benefits of a Business

Process Management System or BPMS for short (see Chap. 9). After all, when a BPMS takes care of assigning work to resources it becomes less relevant where these resources are located geographically. In this sense, this heuristic can be seen as a special form of the integral technology heuristic (see later in this chapter). The specific advantage of this measure is that resources can be committed more flexibly, which gives a better utilization and possibly a better throughput time. The introduction of a BPMS and training of the workforce may, of course, be substantial.

Split responsibilities: "Avoid shared responsibilities for tasks by people from different functional units". The idea behind this heuristic is that activities for which different departments share the responsibility are more likely to be a source of neglect and conflict. Reducing the overlap in responsibilities should lead to a better quality of activity execution. Also, a higher responsiveness to available work may be developed, so that customers are served quicker. On the other hand, applying this heuristic may reduce the effective number of resources that is available for a work item. This may have a negative effect on its throughput time, as more queuing may occur, and the organization becomes less flexible.

Customer teams: "Consider to compose work teams of people from different departments that will take care of the complete handling of specific sorts of cases". Depending on its exact desired form, the customer team heuristic may be implemented by the case assignment heuristic. On the other hand, a customer team may involve more workers with the same qualifications, in this way relaxing the strict requirements of the case assignment heuristic. Advantages and disadvantages are similar to those of the case assignment heuristic. In addition, working as a team may improve the attractiveness of the work, which is a quality aspect.

Numerical involvement: "Minimize the number of departments, groups and persons involved in a business process". Applying this heuristic may lead to less coordination problems. Less time spent on coordination makes more time available for the processing of cases. Reducing the number of departments may lead to less split responsibilities, with similar pros (quality) and cons (flexibility) as the split responsibilities heuristic discussed before. Note that smaller numbers of specialized units may prohibit the build up of expertise (a quality issue) and routine (a cost issue).

Case manager: "Appoint one person to be responsible for the handling of each type of case, the case manager". The case manager is responsible for a specific order or customer. Note that a case manager is not necessarily someone who works on the actual case and even if the person does, not exclusively so. The difference with the case assignment practice is that the emphasis is on management of the process—not its execution. The most important aim of the heuristic is to improve upon the external quality of a business process. The business process will become more transparent from the viewpoint of a customer: the case manager provides a single point of contact. This, in general, positively influences customer satisfaction. It may also have a positive effect on the internal quality of the business process, as someone is accountable for and committed to correcting mistakes. Obviously, the assignment of a case manager has financial consequences as capacity must be devoted to this job.

Table 8.4 Characteristics of the organization structure heuristics

	Time	Cost	Quality	Flexibility
Case assignment	·	·	+	−
Flexible assignment	+	−	·	+
Centralization	+	−	·	+
Split responsibilities	·	·	+	−
Customer teams	·	·	+	−
Numerical involvement	+	−	·	−
Case manager	·	−	+	·

The assessment of the heuristics that target the side of the organizational structure involved in a business process can be seen in Table 8.4.

The second set relates to the organizational population and the resources being involved in terms of type and number. This category includes three heuristics: extra resources, specialist-generalist, and empower.

Extra resources "If capacity is insufficient, consider increasing the available number of resources". This is straightforward heuristic, which aims at extending capacity. extending the capacity to handle cases, in this way reducing queue time. It may also help to implement a more flexible assignment policy. Of course, hiring or buying extra resources has its cost. Note the contrast of this heuristic with the numerical involvement heuristic.

Specialist-generalist "Consider to deepen or broaden the skills of resources". Participants in a process may be turned from specialists into generalists or the other way around. A specialized resource can be trained to gain more qualifications. A generalist, on the other hand, may be assigned to the same type of work for a longer period of time, so that skills in this area deepen while other qualifications become obsolete. In the context of designing an entirely new business process, the application of this heuristic comes down to considering the specialist-generalist ratio of new hires. Clearly, specialists build up routine more quickly and may have more profound knowledge in an area than generalists have. As a result, they work more quickly and deliver higher quality. On the other hand, the availability of generalists adds more flexibility to the business process and can lead to a better utilization of resources. Depending on the degree of specialization or generalization, either type of resource may be more costly. Note that this heuristic differs from the triage concept in the sense that the focus is not on the division of activities.

Empower "Give workers most of the decision-making authority instead of relying on middle management". In traditional business processes, substantial time may be spent on authorizing the outcomes of activities that have been performed by others. If workers are empowered to take decisions autonomously, this may result in smoother operations with lower throughput times. The reduction of middle management from the business process also reduces the labor cost spent on the

Table 8.5 Characteristics of the organization population heuristics

	Time	Cost	Quality	Flexibility
Extra resources	+	−	·	+
Specialist-generalist	+	·	+	−
Empower	+	·	−	+

processing of cases. A drawback may be that the quality of the decisions is lower and that obvious errors are no longer identified. If bad decisions or errors result in rework, the cost of handling a case may actually increase compared to the original situation.

The assessment of the heuristics for the organization population can be seen in Table 8.5. Note that for the specialist-generalist heuristic, the general effects are included of investing into *more specialized* skills of the workforce. Clearly, investing in generalists gives the opposite effect.

8.2.5 Information Heuristics

The information category describes redesign heuristics related to the information the business process uses, creates, may use or may create. It includes control addition and buffering.

Control addition: "Check the completeness and correctness of incoming materials and check the output before it is sent to customers". This heuristic promotes the addition of controls to a business process. Such additions may lead to a higher quality of the business process execution. Obviously, an additional control will require time, which may be substantial, and absorbs resources. Note the contrast between the intent of this heuristic and that of the activity elimination heuristic discussed earlier.

Buffering: "Instead of requesting information from an external source, buffer it and subscribe to updates". Obtaining information from other parties is a time-consuming part in many business processes. By having information directly available when required, throughput times may be substantially reduced. This heuristic can be compared to the caching principle that microprocessors apply. Of course, the subscription fee for information updates may be costly. This is certainly so if we consider information sources that contain far more information than is ever used. Substantial cost may also be involved with storing all the information. Note that this heuristic is a weak form of the integration heuristic that is yet to be discussed.

A summary of the general effects of the two information heuristics are shown in Table 8.6.

Table 8.6 Characteristics of the information heuristics

	Time	Cost	Quality	Flexibility
Control addition	−	−	+	·
Buffering	+	−	·	·

Table 8.7 Characteristics of the technology heuristics

	Cost	Quality	Time	Flexibility
Activity automation	+	−	+	−
Integral technology	+	−	·	·

8.2.6 Technology Heuristics

This category describes redesign heuristics related to the technology the business process uses or may use. It includes activity automation and integral technology.

Activity automation: "Consider automating activities". A particularly positive result of automating activities may be that activities can be executed faster and with a more predictable result. An obvious disadvantage is that the development of a system that performs an activity may be very costly. Generally speaking, a system performing an activity is also less flexible in handling variations than a human resource. Instead of fully automating an activity, it may also be considered to provide automated support to a resource executing an activity.

Integral technology: "Try to elevate physical constraints in a business process by applying new technology". In general, new technology can offer all kinds of positive effect. For example, the application of a BPMS may result in less time that is spent on routing (electronic) work. A Document Management System, in its turn, will open up to all participants the information available on cases. This may result in a better quality of service. New technology can also change the traditional way of doing business by giving participants completely new opportunities. The purchase, development, implementation, training, and maintenance efforts related to technology obviously incur costs. In addition, new technology may instill workers with apprehension, which may decrease the quality of the business process.

The two technology heuristics can be characterized as is shown in Table 8.7.

8.2.7 External Environment Heuristics

The external environment category contains heuristics that try to improve upon the collaboration and communication with the third parties. These include trusted party, outsourcing, and interfacing.

Table 8.8 Characteristics of the external environment heuristics

	Cost	Quality	Time	Flexibility
Trusted party	+	+	·	−
Outsourcing	+	+	·	−
Interfacing	+	·	+	−

Trusted party: "Instead of determining information oneself, use the results of a trusted party". Some decisions or assessments that are made within a business process are not specific to that process. Other parties may have determined the same information in another context, which—if it were available—could replace the decision or assessment. An example is the creditworthiness of a customer that bank A wants to establish. If a customer can present a recent creditworthiness certificate of bank B, then bank A may be likely to accept it. Obviously, the trusted party heuristic reduces cost and may even cut back throughput time. On the other hand, the quality of the business process becomes dependent upon the quality of some other party's work. Some coordination effort with trusted parties is also likely to be required, which diminishes flexibility. This heuristic is different from the buffering heuristic, because the business process owner is not the one obtaining the information.

Outsourcing: "Consider outsourcing a business process completely or parts of it". Another party may be more efficient in performing the same work, so it might as well perform it for one's own business process. The obvious aim of outsourcing work is that it will generate less cost. A drawback may be that quality decreases. Outsourcing also requires more coordination efforts and will make managing the business process more complex. Note that this heuristic differs from the trusted party heuristic. In the case of outsourcing, an activity is executed at run time by another party. The trusted party heuristic allows for the use of a result in the (recent) past.

Interfacing: "Consider a standardized interface with customers and partners". The idea behind this heuristic is that a standardized interface diminishes the occurrence of mistakes, incomplete applications, or unintelligible information exchanges. So, a standardized interface may result in less errors (quality) and faster processing (time). However, by standardizing the interface it becomes impossible to deal with exceptional situations (flexibility). The interfacing heuristic can be seen as a specific interpretation of the integration heuristic, although it is not specifically aimed at customers.

The characteristics of the external environment heuristics are summarized in Table 8.8. This concludes the description of the various heuristics. In what follows, we will be looking at their application.

8.3 The Case of a Health Care Institution

At this point, we will consider a realistic case of a healthcare institute (see Fig. 8.2). The case concerns the Intake process for elderly patients with mental problems, which is styled after the way this is carried out in the Eindhoven region. The Intake process starts with a notice by telephone at the secretarial office of the healthcare institute. This notice is done by the family doctor of the person who is in need of mental treatment. The secretarial worker inquires after the name and residence of the patient. On basis of this information, the doctor is put through to the nursing officer responsible for the part of the region that the patient lives in.

The nursing officer makes a full inquiry into the mental, health, and social status of the patient in question. This information is recorded on a registration form. After this conversation had ended, this form is handed in at the secretarial office of the institute. Here, the information on the form is stored in the information system and subsequently printed. For new patients, a patient file is created. The registration form as well as the print from the information system are stored in the patient file. Patient files are kept at the secretarial office and may not leave the building. At the secretarial office, two registration cards are produced for, respectively, the future first and second intaker of the patient. The registration card contains a set of basic patient data. The new patient is added on the list of new notices.

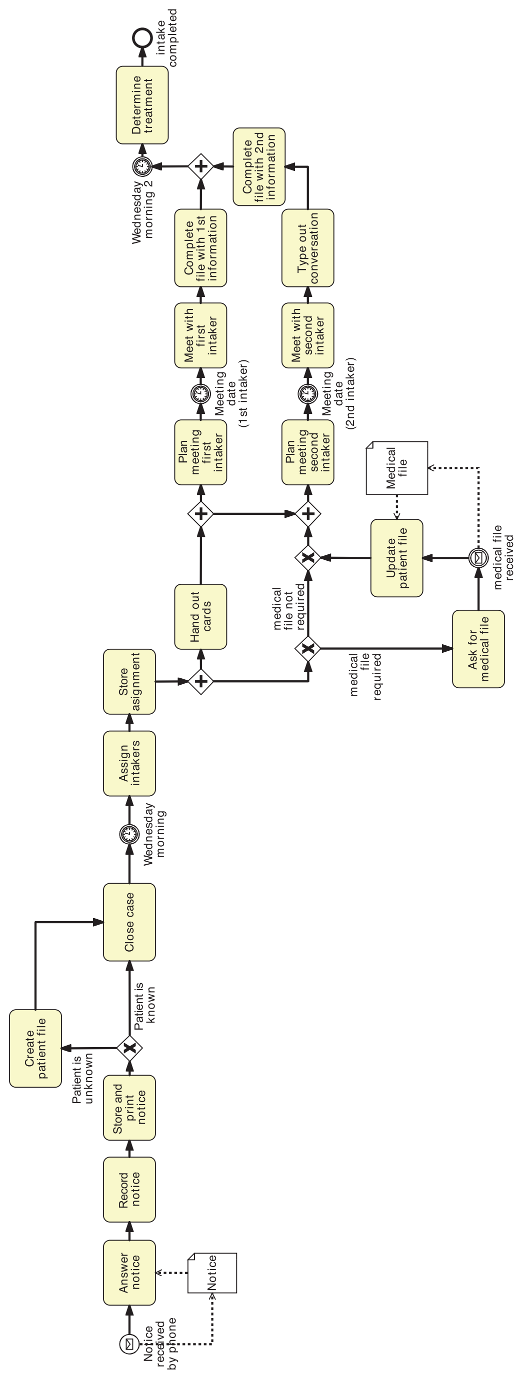
Halfway during each week, on Wednesday, a staff meeting of the entire medical team takes place. The medical team consists of social–medical workers, physicians, and a psychiatrist. During this meeting, the team leader assigns all new patients on the list of new notices to members of the team. Each patient will be assigned to a social–medical worker, who will act as the *first intaker* of the patient. One of the physicians will act as the *second intaker*. In assigning intakers, the team leader takes into account their expertise, the geographical region they are responsible for, earlier contacts they might have had with the patient, and their case load. The assignments are recorded on an assignment list which is handed to the secretarial office. For each new assignment, it is also determined whether the medical file of the patient is required. This information is added to the assignment list.

The secretarial office stores the assignment of each patient of the assignment list in the information system. It passes the produced registration cards to the first and second intaker of each newly assigned patient. An intaker keeps this registration at times when visiting the patient and being at the office. For each patient for which the medical file is required, the secretarial office prepares and sends a letter to the family doctor of the patient, requesting for a copy of the medical file. As soon as this copy is received, the secretarial office will inform the second intaker and add the copy to the patient file.

The first intaker plans a meeting with the patient as soon as this is possible. During the first meeting, the patient is examined using a standard checklist which is filled out. Additional observations are registered in a personal notebook. After a visit, the first intaker puts a copy of these notes in the file of a patient. The standard checklist is also added to the patient's file.

The second intaker plans the first meeting only after the medical information of the physician—if required—has been received. Physicians use dictaphones to record

Fig. 8.2 The intake process



their observations made during meetings with patients. The secretarial office types out these tapes, after which the information is added to the patient file.

As soon as the meetings of the first and second intaker with the patient have taken place, the secretarial office puts the patient on the list of patients that reach this status. For the staff meeting on Wednesday, they provide the team leader with a list of these patients. For each of these patients, the first and second intaker together with the team leader and the attending psychiatrist formulate a treatment plan. This treatment plan formally ends the intake procedure.

What we will now do is discuss three alternatives to the process, which all have been generated using the heuristics discussed so far. In other words, each design is derived from the existing process by the application of one or more redesign heuristics at appropriate places. To guide the derivation of these designs, we will assume that bringing back the cycle time of this process is the main objective.

8.3.1 Sending Medical Files by Post

A considerable part of the cycle time in the Intake process is consumed by the wait time for the medical file to arrive by post. On basis of the *integration* and *technology* heuristics we consider the alternative that medical files become available on-line to the mental health care institute. (In practice, this should presumably be restricted to read-only access for patients that are indeed reported to the mental health-care institute.) Note that this alternative presupposes a considerable usage of technology: doctors should store their patient information electronically and communication facilities should be installed as well.

By the direct availability of the medical file, the "Ask for medical file" activity in Fig. 8.2 is replaced by the "Access medical file" activity, which is performed by the secretarial office. Probably, roughly the same time that was spent on preparing and sending a request letter will be required for accessing and printing the patient file. The "Update client file" activity stays in place, but it is not triggered anymore by the "Medical file". The wait time for the medical file is now completely reduced, which favorably influences the cycle time.

8.3.2 Periodic Meetings

As part of the Intake process, the staff meeting is planned at regular weekly intervals, on Wednesdays. During a staff meeting two important things take place:

1. for new cases, the first and second intakers are assigned, and
2. for cases for which both intake interviews have taken place, treatment plans are determined

From a process perspective, periodic restrictions on activities seem odd. Let us assume that an additional analysis of the Intake process points out that the first activity does not really require a meeting context, provided that the team leader has sufficient information on the criteria used for new assignments. Admittedly, the second activity is indeed best performed in the context of a meeting. This is because of the limited availability of the psychiatrists, which prohibits more flexible measures.

On basis of the *case-based work* heuristic, we consider as an alternative to the existing process that the team leader will carry out new case assignments as soon as they are due; the weekly meeting is strictly used for determining treatment plans. The process in Fig. 8.2 then changes in the sense that the "Wednesday morning" event is removed. Because the information is available to the team leader for taking assignment decisions, it can be expected that the original duration of the activity decreases. This time includes the report of the assignment to the secretarial office. Both the social–medical worker and the physician will no longer spend this time on the case. The cycle time of an average case will drastically drop, on average by 2.5 working days—half a working week—as this is the expected time a new case has to wait before it is assigned (assuming a uniform distribution of cases over the week).

8.3.3 Requesting Medical Files

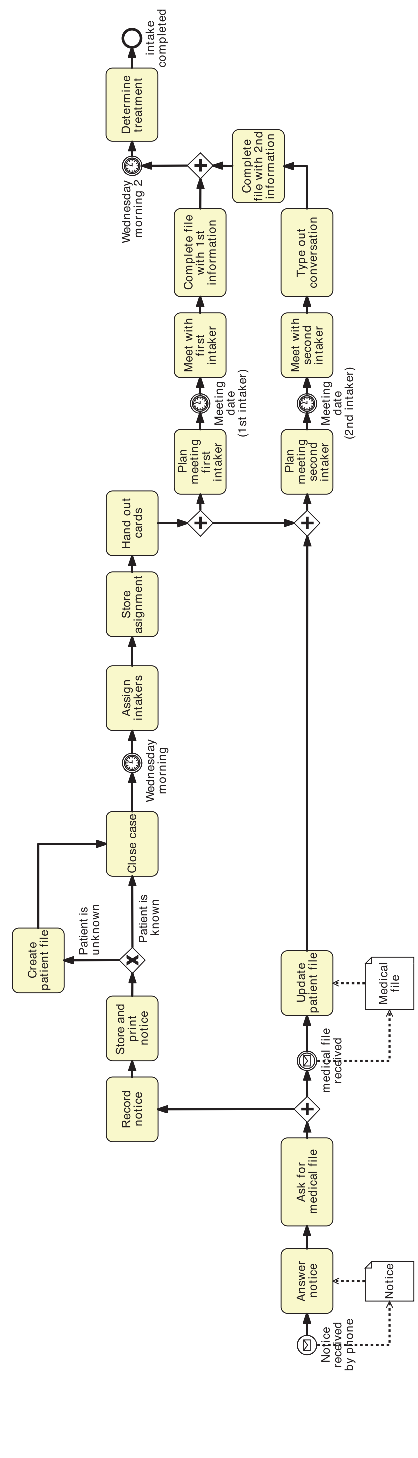
For each new case, a decision has to be made whether the medical file of the patient will be requested. This request is made to the family doctor. It should be noted that the family doctor is also the one who notifies the new case at the initiation of the process. This raises the question whether the *contact reduction* heuristic may be applicable. Closer inspection of the routing of individual cases shows that in 95 % of all new cases the medical file is requested for. This extremely high figure certainly justifies consideration of the *exception* heuristic. After all, not requiring the medical information seems to be the exception.

A combined application of the *contact reduction* heuristic, the *exception* heuristic and the *resequencing* heuristic leads to an alternative process design where the secretarial office directly asks for the medical file after the family doctor makes contact with the mental health care institute. Also, the routine is dropped to determine for each case at a staff meeting whether medical information is required. The new process design is shown in Fig. 8.3.

Note that in this case, the exception heuristic coincides with the secondary interpretation of the *triage* heuristic. What used to be an alternative activity, asking for medical information, has become a general part of the process. As a result, the cycle time is sharply reduced.

This ends the explanation of Heuristic Process Redesign. While this methodology still involves a fair dose of creativity and skills, the availability of redesign heuristics helps to more easily generate new designs. Each time the heuristics are used, it makes sense to consider which sets of heuristics are applicable by taking the redesign goals into account.

Fig. 8.3 The intake process after the medical file redesign



Exercise 8.6 Consider the three redesign scenarios that were discussed previously. As explained, these scenarios focus on the reduction of cycle time of the process in question. Can you explain how the other performance dimensions are affected by these scenarios?

8.4 Product-Based Design

The methodology of *Product-based Design* is very different from Heuristic Process Redesign. First of all, it aims at radically rethinking how a particular product or service can be created instead of using an incremental approach as we saw before.

Secondly, not so much the existing process is the starting point of the redesign. Rather, the characteristics of the particular product that the process-to-be is expected to deliver are used to, in fact, *reason back* what that process should look like. Think of it in this way: if you like to produce a red, electronic vehicle on four wheels, you are certain that the process to produce it at some stage must involve the production or purchase of a chassis, that there is a step needed to assemble four wheels to that chassis, that you will need to insert a battery at some point, and that you will need to paint the vehicle (if you cannot get your hands on red parts, that is). You are perhaps not sure in what order these things need to take place exactly, but you can at least identify some logical dependencies. For example, you are better off painting the vehicle *after* you acquired the chassis.

The idea behind Product-based Design is that by *ignoring* the existing process to create a particular product it becomes feasible to develop the leanest, most performative process possible. While Product-based Design is more ambitious than Heuristic Process Redesign, it is also more limited in its application scope: It has been specifically developed to design processes that produce informational products, e.g. a decision, a proposal, or a permit. It is this informational product that is analyzed and laid down in a *product data model*. There is a striking resemblance between this model and the *bill-of-material* (BOM) as used in the manufacturing domain. The product data model is subsequently used by the designer to determine the best process structure to create and deliver that product. Given that there are, in general, multiple ways to produce an informational product, Product-based Design discloses all of these.

After this brief introduction, we will now outline the steps of Product-based Design. The most important stages are:

1. Scoping: In this initial phase the business process is selected that will be subject to the redesign. The performance targets for this process are identified, as well as the limitations to be taken into consideration for the final design.
2. Analysis: A study of the product specification leads to its decomposition into information elements and their logical dependencies in the form of a *product data model*. The existing business process—if any—is diagnosed to retrieve data that are both significant for designing the new business process and for the sake of evaluation.

3. Design: Based on the redesign performance objectives, the product data model, and (estimated) performance figures, one or more process designs are derived that best match with the design goals.
4. Evaluation: The process designs are verified, validated with end-users, and their estimated performance is analyzed in more detail. The most promising designs can be presented to the commissioning management to assess the degree in which objectives can be realized and to select the most favorable design to be implemented.

These phases are presented in a sequential order, but in practice it is often desirable that iterations will take place. For example, the evaluation phase is explicitly aimed at identifying design errors, which may result in rework on the design. The focus of the remainder of this section will be on the analysis and design phases. The purpose is not to treat all the details of this method, but to give the reader an idea of the approach, its main artifacts, and how it is different from Heuristic Process Redesign.

8.4.1 Analysis: Creating a Product Data Model

In the analysis phase, all distinguished materials that may be relevant sources on the characteristics of the product to-be-delivered are analyzed. The purpose is to identify information elements, their dependencies, and the processing logic involved, i.e. how existing information can be combined to create new information. For a proper representation of this information, we will be using a tree-like structure that we will refer to as a *product data model*. This structure is different from the traditional BOM found in manufacturing, which is due to several differences between informational products and physical products. These differences lead to two important updates of the traditional BOM. First, the same piece of information may be used to manufacture various kinds of new information. Therefore, also non-tree-like structures are possible. For example, the age of an applicant for a life insurance may be used to estimate both (a) the involved health risks for that patient and (b) the risks of work related accidents. Secondly, there are no physical constraints to produce an informational product and therefore there are typically multiple ways to derive a piece of information. For example, health risks may be estimated using either a patient questionnaire or a full medical examination of that patient.

At this point, we present a graphical example of a product data model, as shown in Fig. 8.4.

All nodes in this figure correspond to information elements that may be used to decide whether some candidate is suitable to become a helicopter pilot in the Dutch Air force. We will refer to this model throughout the remainder of this section as the helicopter pilot product data model . Arcs are used to express the dependencies between the various pieces of information, i.e. the information elements. The meaning of the information elements is as follows:

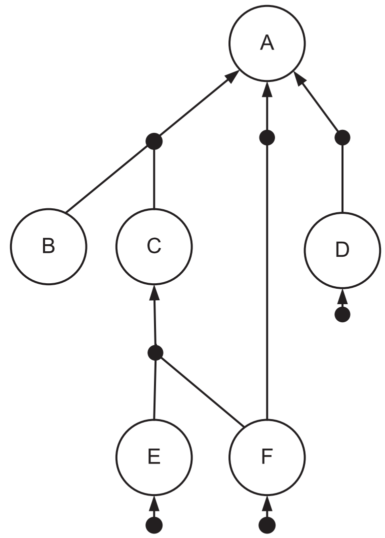


Fig. 8.4 The helicopter pilot product data model

- A: suitability to become a helicopter pilot.
- B: psychological fitness.
- C: physical fitness.
- D: latest result of suitability test in the previous two years.
- E: quality of reflexes.
- F: quality of eye-sight.

Each incoming arc of a node signifies an *alternative way* of determining a value for the corresponding information element for a specific case. If outgoing arcs of multiple nodes are *joined*, this means that values of all of the corresponding information elements are required to determine a value for the information element the arrow leads to. There are also information elements which have incoming arrows that do not origin from other information elements. These relate to those elements that do not rely on the values of other information elements, e.g. element B. We will refer to such information elements as *leaf elements*.

One of the things that is expressed in Fig. 8.4 is that there are three ways to determine a value for information element A. The suitability of a candidate (a) can be determined on the basis of:

1. the combined results of the psychological test (B) and the physical test (C)
2. the result of a previous suitability test (D), or
3. the candidate's eye-sight quality (F)

The way in which a new piece of information is determined on the basis of one or more pieces of other information is called a *production rule* or an *operation*. In reality, different production rules may be applicable under different conditions. It may be the case that a pilot's eye-sight is extremely bad (F), which directly gives as a result that the candidate is not suitable (A). However, in a more common case, the eye-sight quality is one of the many aspects that are incorporated in a physical test (B), which should be combined with the outcome of the psychological test (C) to determine the suitability result (A). Also, not for each candidate that applies to become a pilot any previous test result (D) will be available—quite the contrary. But if there is one of a recent date, it can be used directly.

From the helicopter pilot product data model it becomes clear how the dependencies between data may be used to derive a favorable design. For example, if the target is to minimize the cost it may be wise to check first whether there is a previous test result and next to check the eyes of the candidate. Only if these checks do not lead to rejecting the candidate, a full examination is additionally required. Obviously, the expected cost of all these activities really determine whether this is a good design.

In practice, when analyzing materials that cover the product specification, it is a good idea to distinguish the top information element first. Examples of typical top elements are:

- for a banking process: the decision whether a loan should be granted to a company and, if so, under which conditions and for which amount.
- for a claim process of a social security agency: the decision whether an applicant should receive an unemployment allowance and if so for what reasons, for which period, and for which amount.
- for an intake process of an insurance company: the decision whether a family can be accepted as the holders of a health insurance policy.

Using the top element as the desired end result, it is a logical exercise to identify the information that can be used to directly render a value for the top information element. Obviously, this approach can be repeated for the newly found information elements.

Instead of such a top-down analysis, it may at times be more attractive to start at the beginning of the existing process, for example by analyzing application forms, complaint forms, and request forms that are in use to start the process. This is certainly feasible, but it bears the risk of the inclusion of superfluous information elements in the product data model. In a practical application of Product-based Design for a Dutch bank, we compared a posteriori the amount of information that was originally obtained in the business process and the information that was obtained in the final design. This comparison showed that almost 30 % of the originally obtained information was superfluous.

Another issue is how to pick the right information elements in a product data model. The following aspects are relevant for this choice:

1. an information element is too large if different parts of it are used in different production rules; the information element should be broken up to enable the application of production rules without determining irrelevant information.
2. information elements should not be necessarily associated with their physical manifestation, nor is it necessary that physical information carriers have an information element counterpart (avoid information elements like “intake form” or “computer screen output”).

3. information elements may be atomic, for example a name or a credit score, or composite. Examples for the latter are: all members of a family, a listing of all the requested products with their characteristics, or an overview of all the payment conditions that are in effect. The type of a composite information element is composed type, e.g. a set of numerals, free text, or a Boolean value.

Exercise 8.7 The following is an excerpt of the stipulations of a Dutch bank concerning medium length business loans:

> The funds for a medium length loan that is made available to a client but which is not withdrawn by the client must be placed on the money market. If the funding cost of the loan is higher than the rewards of the temporary placing, this difference is the basis for the monthly disposal provision. The disposal provision amounts to half of this difference with a minimum of $1/12$ % per month. The disposal provision should be part of the loan proposal.

Develop a product data model. Consider the "loan proposal" as the top information element. You may leave out the production rules for this exercise.

The next step in completing the product data model is describing as accurately as possible the involved production rules. All the production rules that relate to a specific product data model are referred to as its *production logic*. The step to determine the production logic may either follow up on the complete identification of all production rules, or may take place as soon as a new production rule has been distinguished. The production logic specifies how the value of an output information element may be determined on the basis of the values of its inputs. Note that some of the inputs may not be used in every calculation, but required for specific cases or to test constraints. The description of production logic may be given in pseudo code or another rather precise specification language. For example, using the helicopter pilot product data model again: The production rule that relates to the use of a value for F to determine a value for A may be: "If a candidate's vision of either or both eyes as expressed in diopters is above $+0.5$ or below -0.5, then such a candidate is considered as *unsuitable* to become a helicopter pilot".

Exercise 8.8 In the helicopter pilot product data model, there are two additional ways to determine someone's suitability to become a helicopter pilot beyond the one that was just mentioned. Provide sample production rules for both of these. Indicate separately under which conditions they are applicable.

The most important criteria on any language for the purpose of specifying the production logic are expressiveness and clarity. A representation of the production logic for each production rule is valuable for at least four reasons:

1. Writing out the full specification is a direct validation on the distinguished inputs of the involved production rule: forgotten inputs or bad data types can be detected.
2. An analysis of the production logic is relevant for the estimation of performance characteristics when actually determining information with this production rule:

labor and computer cost, speed, accuracy, etc. These characteristics are useful—as will be shown—in designing the workflow.
3. A representation of production logic that is of an algorithmic nature can be used as a functional specification for the information system that can execute this production rule. This is an important stepping stone for system development activities that may follow up the workflow redesign.
4. If the production logic is not totally algorithmic, it is likely that a human operator must execute it in practice. Then, the production logic is of use to develop task instructions for these operators.

The most accurate descriptions of production logic can be given when it involves an exact algorithm. In such a case, we will speak of a *formal* production rule. However, the production of many information elements in office settings is often not or not completely formal. It may be relevant, required or even the only option that a human passes a judgment without following a totally formalized decision making process. A typical example of such a non-formal production rule would involve the question whether some one is responsible for one's own discharge. If there is a dispute, opposite explanations of different parties must be taken into account. A human expert may be called in to determine the plausibility of these explanations, as there are no known algorithms to do this. Another example is whether the purchase of some good is ethically admissible, which is a relevant piece of information in determining whether a loan should or should not be granted for this purpose. This decision may suppose a value system that is hard to describe formally.

If a production rule is not of a formal nature it is important to at least check if all the required inputs are identified. Also, as noted before, describing as precisely as possible how the output must be produced on the basis of its inputs is a valuable step in determining working instructions for non-formal production rules. These working instructions can be provided to the people who will actually be responsible for determining the involved information in practice, that is to say: when the designed process is put into production. These rules may very well signal where Knowledge Management Systems can be beneficial.

Exercise 8.9 Consider an issue-to-resolution process (see Chap. 1). Determine two information elements that are important to provide a value for in this process, one of which involves a formal production rule and the other which is not.

Although a complete univocal procedure may not exist for a production rule, it is often the case that *under specific circumstances* this decision is completely formal. For example, in determining whether someone qualifies for an unemployment allowance it is relevant to determine what the usual pattern of labor hours for this person was during a week. In special cases, someone's actual labor pattern may be whimsical, e.g. due to a combination of different jobs or seasonal labor. So, determining the usual pattern is best done in those cases by using human interpretation.

However, if the applicant has a steady pattern of working hours for a long period of time, e.g. eight hours per day within one job, from Monday to Friday over the last five years, determining the usual labor pattern is straightforward and can be described formally. Another example is the authorization function that must be performed to determine whether a loan proposal may be sent to a client. Generally, this function is a matter of human judgment, which must take a large number of factors into account. On the other hand, if the loan sum is small, the client is a known client with sufficient coverage, and the purchasing goal is standard, the proposal may be acceptable with no further inspection.

When all information elements, their inter-dependencies and the production logic have been described, a final analysis step follows. This last step is required to identify all the characteristics that are relevant to design a business process that is efficient in terms of cost, reliability, or speed. The final analysis step consists of three steps, which we will describe here only briefly:

Source analysis The source analysis is aimed at identifying the sources of all the leaf elements in the product data model, i.e. the ones that do not rely on other information elements. Typically, multiple sources are available to obtain the same piece of information. For example, a record of historical grants of unemployment allowances may be obtained directly from an applicant or from the agencies that have provided these allowances in the past. Another example is somebody's payable debt position. In Europe, a bank may obtain this information from different scoring agencies (e.g. Experian, Equifax, Schufa, BKR). Different ways of obtaining information may have different characteristics. A client may be very willing to self-report information about credit positions, but this information may not be very reliable. Similarly, local authorities may provide correct domestic information at a very low cost, but their response time may be considerable. Depending on the criteria that are identified in the scoping phase, it is wise to first identify the possible sources for each leaf element and subsequently score them on relevant points of comparison. Assuming general performance goals like improving efficiency, bringing back throughput time while maintaining (or improving) an existing quality level, relevant points of comparison for each leaf are: cost of obtaining it, delivery speed of the information, availability of the specific information and reliability of the provided information.

Production analysis The production analysis focuses on the identified production rules with the aim to estimate the involved cost, speed, and quality of producing the new information. As there may be different ways to obtain a piece of information, similarly different production rules typically exist for the same piece of information. Designing the process is for a large part concerned with selecting the right set and the right execution order of production rules given a set of performance targets. From these targets it becomes clear which optimization criteria are prevailing. For example, suppose that an important performance target aims at a reduction of the labor cost. If there are two rule for the same piece of information, the one that takes the least amount of time is the one may be preferred. After all, the formal production rule may be automated. Obviously, this efficiency gain should be set off against the cost and time, which is involved with developing the software. It should be noted here that the production analysis is a very time-consuming part of the analysis phase, even more so when there is a poor tradition of operations measurement within the company at hand. The time that should be invested in obtaining reliable information should be balanced against the desired reliability of the quality estimates of the process design.

Fraction analysis The fraction analysis involves a study of the distribution of information element values. As we already explained, an information element may carry specific values. For example, the value of the information element "travel insurance required" may be either yes or no. The figures on the likelihood of information elements taking on specific values may be very relevant to design an efficient process. In combination with the figures from the production analysis (cost, speed, etc.), favorable orderings of executing production rules may be determined. For example, suppose that there are two production rules for the same information element with different applicability domains, with very different input elements, but with a similar cost structure to obtain values for them. In such a case, it may be wise from a cost perspective to aim at executing the rule with the widest applicability first. Only if this production rule does not yield an outcome, applying the other rule may be tried.

As has become clear, each of the separate analyzes are useful for deciding on the actual design of the to-be business process. Note that the steps not necessarily need to be executed in the order they are described here. The heart of the matter is that the results of these analyzes together provide a good basis for the actual act of process design.

8.4.2 Design: Deriving a Process from a Product Data Model

In this part, we will consider how a product data model can be used to derive a process design. For that purpose we will refer again to the helicopter pilot product data model. When developing a process design, we will allow for the creation of an activity for each information element in the product data model. Such an activity is concerned with creating a value for that information element according to a particular production rule. If the need is there, more than one activity for each information element may appear. Such duplicates, for example, can help to improve the readability of a process model that describes the process design.

Activities may only be incorporated in a process model in a way such that the dependencies between the information elements in the product data model are respected. That means that an information element can only be created by invoking a corresponding activity if the process design ensures that the required values for its inputs elements may have become available. So, for example, if we like to create an activity that produces a value for element X on the basis of a production rule that requires input values for Y and Z, the process design should ensure that values for Y and Z are created before this new activity is initiated. A process design that is generated with Product-based Design in such a way is called *correct*. Note that activities for creating values for leaf elements may be inserted at any stage: They do not require inputs after all.

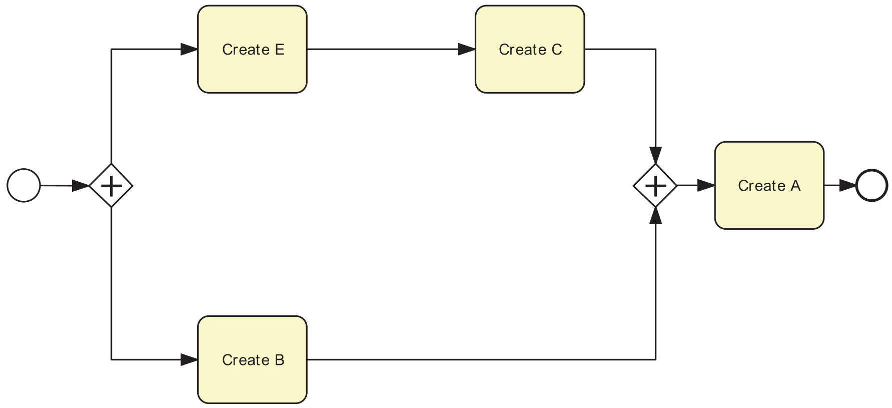


Fig. 8.5 An incorrect process design for the helicopter pilot product data model

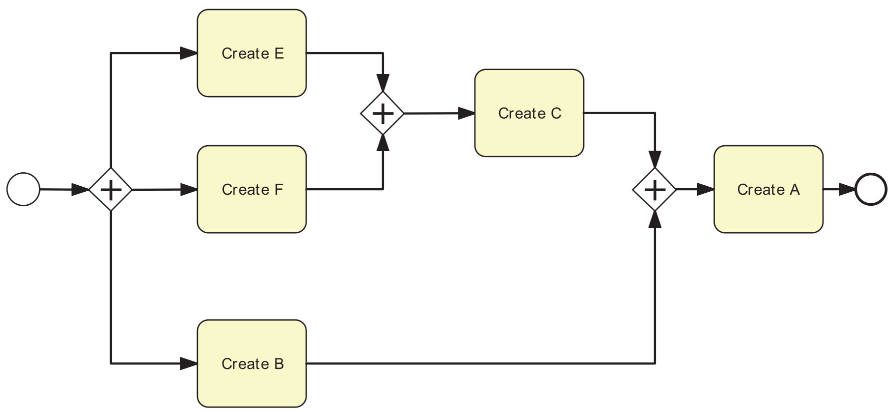


Fig. 8.6 A correct process design for the helicopter pilot product data model

Consider the process models that are depicted in Figs. 8.5 and 8.6. They represent alternative process designs. Both designs include an activity that is involved with the creation of information element A. In Fig. 8.5 it can be seen that the "Create A" activity will be invoked after the creation of information element B, which is created in parallel to the successive creation of values for E and C. However, the product data model in Fig. 8.4 shows no production rule for creating a value for C on the basis of E alone. Yet, there is a production rule that shows how the combined use of E and F can be used for that, but in this design no value for F is determined before the creation of a value for C. The design in Fig. 8.5 is, therefore, *not correct*.

Compare this design with the one in Fig. 8.6. Here, all creation activities are either producing values for leaf elements in the product data model (E, F, B) or create values for information elements on basis of production rules for which the inputs are created by preceding activities (C, A). The design in this figure is, therefore, *correct*.

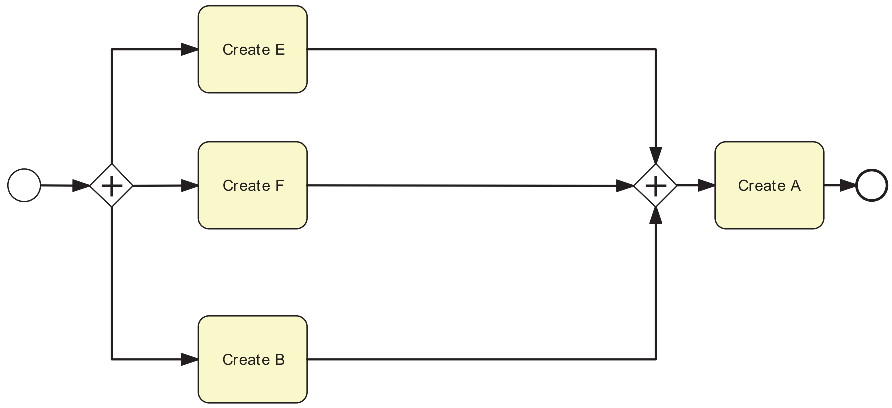


Fig. 8.7 An alternative process design for the helicopter pilot product data model

Exercise 8.10 Consider the process design that is visualized in Fig. 8.7. Is this a correct process design? Motivate your answer.

The second important criterion to be taken into consideration for a process design that is generated with Product-based Design is called *completeness*. A process design may or may not cover all the information elements that have been identified in a product data model. If a process design covers all information elements in a given product data model we will call it *complete*. Consider the designs in Figs. 8.5, 8.6, and 8.7. None of these designs cover the creation of a value for D, even though D is part of the product data model that these designs refer to. We therefore say that these designs are *not complete*.

Leaving out the creation of values for information elements from a process design may be a deliberate choice. In such a case, leaving out D inhibits the potential determination of a value for A using the production rule that has D as an input. It may very well be that on the basis of the analysis of data, the process designer deliberately decided not to include this option. This would make sense in a situation where very few applicants try to re-apply to become a helicopter pilot. After all, including this option may complicate the design, but not add much value in practical terms. On the other hand, the designer may have overseen this option overall, which explains why it is useful to check for completeness.

Exercise 8.11 Develop a *complete* process design on the basis of helicopter pilot product data model and capture that design as a process model.

Note that a process design that is complete with respect to information elements may still not exploit all available production rules. Without exact information on which production rules are used for which creation activities, though, this may be hard to determine. Clearly, it may be important for designers to check in practical applications of Product-based Design whether they have exploited all the opportunities that a product data model provides.

We can impose other quality criteria on process designs and many of these criteria can be extracted from more widely applicable ones. For example, we often like to capture a process design in the form of a *sound* process model, see Chap. 5.4.1.

At this point, we consider as a more important issue the *performance* of the process that is designed with Product-based Design. We mentioned that during the scoping phase of a project, the performance criteria are to be established for the process in question. One of the most important trade-offs is whether the design should result in a *fast* process versus an *efficient* process. A fast process can be designed by exploiting the opportunities to work in parallel. This may, however, not at all be an efficient process. Given that, in general, there may be different ways to establish a value for the same information element, a parallel process potentially induces too much work to be done. A more efficient way of carrying out a process would be to do as little work as possible, prioritize less costly yet effective activities, and only refer to alternatives if absolutely necessary. Note how these two different perspectives coincide with the parallelism and knock-out redesign heuristics we discussed earlier in this chapter.

Exercise 8.12 Develop a complete process design on the basis of helicopter pilot product data model and capture it as a process model. The design should involve a cost-efficient process. You may assume that the production rules to create a value for A on the basis of D or F are rather, just as the creation of values for the leaf elements. The use of the production rule for A that has B and C as inputs is, however, much more expensive.

While many other performance criteria can be taken into account when applying Product-based Design, we will not deal with them at this place. It is important to realize that a more sophisticated notion of performance will also assume more detailed information to be available. For example, if it is important to design a *secure* process it is important to understand the *risks* that are involved with obtaining or creating values for information elements.

8.5 Recap

In this chapter, we discussed the motivation for process redesign. The Devil's Quadrangle helped us to clarify that many redesign options have to be discussed from the perspective of a trade-off between time, cost, quality, and flexibility. Redesign can be approached as a purely creative activity or using a systematic technique. In this chapter, we focus on two of such systematic approaches, namely Heuristic Process Redesign and Product-based Design.

The methodology of Heuristic Process Redesign involves the phases of initiation, design, and evaluation. Various heuristics are available to support the design phase. They focus on the seven areas being related to processes, including customers, business process operations, business process behavior, organization, information, technology, and the external environment. We studied the application of some the heuristics in the case of a health care institution.

As an alternative method, we discussed a product-based design approach. The idea is to use a decomposition model of the product as a starting point, and infer options on what the process model for constructing the product could look like. Central to this method is the analysis and specification of the product data model. The actual design can then be tuned to the desirable performance characteristics of the process.

8.6 Solutions to Exercises

Solution 8.1 This is a hands-on exercise. A potential to approach this question might be to think of companies that offered services which are now provided by other companies via the internet.

Solution 8.2

1. "An airline has seen its profits falling over the past year. It decides to launch a marketing campaign among its corporate clients in the hope that it can extend its profitable freight business": Not a redesign initiative, no link to process.
2. "A governmental agency notices that it is structurally late to respond to a citizen's queries. It decides to assign a manager to oversee this particular process and to take appropriate counter actions": Redesign refers to *participants* and the *business process* itself.
3. "A video rental company sees that its customer base is evaporating. It decides to switch to the business of promoting and selling electronic services through which clients can see movies on-line and on-demand": Not so much a process redesign initiative; although there is certainly a link to process and products, this is much more a strategic initiative.
4. "A bank notices internal conflicts between two different departments over the way mortgage applications are dealt with. It decides to analyze the role of the various departments in the way applications are received and handled to come up with a new role structure": A redesign initiative touches on *process* and *participants*.
5. "A clinic wants to introduce the one-stop-shop concept to improve over the situation that its patients need to make separate appointments for the various diagnostic tests that are part of a procedure for skin cancer screening": A redesign initiative touches on *process* and *customers*.

Solution 8.3

1. Dealing with a customer complaint: Suitable.
2. Carrying out cardiovascular surgery: Mildly suitable, there are physical constraints involved here.
3. The production of a wafer stepping machine: Not very suitable, highly physical process.