

# Individual Differences in the Managerial Mental Representation of Business Processes

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## Abstract

The main issue of business reengineering, as demanded by Hammer, is a specific orientation of management towards business *processes*. We will analyse the psychological implications. Up to now process orientation has not been a main issue of research in experimental cognitive psychology. Our basic research concerning individual cognitive differences has shown that stable preferences do exist for predicative versus functional cognitive structures. Predicative thinking emphasises the preference in thinking in terms of judgements and in terms of networks of relations and structures; functional thinking emphasises the preference of thinking in terms of effects, organising processes and sequences of actions. We are working together with managers in an ongoing research project. In several case studies we are trying to detect a correlation between a process orientation in the observable managerial behaviour, the beliefs of the managers and their individual preference for predicative versus functional mental models.

## 1. Cognitive aspects of business reengineering

Hammer and Champy consider Business Process Reengineering (BPR) as a very powerful instrument. It is

...the fundamental radical redesign of business processes to achieve dramatic improvements in critical contemporary measures of performance, such as cost, quality, service, and speed. (Hammer & Champy, 1993, p. 32).

Nevertheless, it is reported (e. g. Bashein et al., 1994; Champy, 1995) that apart from the fact that the realisation of this idea is successful, there are a lot of difficulties and even failures. Business reengineering is successful - but only to a certain degree. One of the important hints as to why difficulties could arise is given by Hammer and Champy themselves.

Although this word (process) is the most important in our definition, it is also the one that gives most corporate managers the greatest difficulty. Most business people are not "process-orientated"; they are focused on tasks, on jobs, on people, on structures, but not on processes. (ibid, 1993, p. 35)

In their book Hammer and Champy try to construct a suitable mental model (Johnson-Laird, 1983) of the role which processes play in operating procedures in the reader's mind. For this purpose they give historical examples. It is the method of presentation which induces the idea.

For two hundred years people have founded and built companies around Adam Smith' s brilliant discovery that industrial work should be broken down into its simplest and most basic *tasks*. In the post-industrial business age we are now entering, corporations will be founded and built around the idea of reunifying those tasks into coherent business *processes*. (ibid, p. 2)

The core message of our book, then, is this: It is no longer necessary or desirable for companies to organize their work around Adam Smith' s division of labor. Task-orientated jobs in today' s world of customers, competition, and change are obsolete. Instead, companies must organize work around *process*. (ibid, p. 27/28)

For us they focus on the difference between coherent and process-orientated tasks by means of their examples on the one hand and broken into single tasks on the other hand. "To break work into tasks," refers to the metaphor of a puzzle by which we have characterised below *predicative* thinking. Another quite different approach - the *functional* one - could be the organisation of a mechanism, for which we use the metaphor of a gear mechanism (see Fig. 1).

It was railroad companies that invented the modern business bureaucracy - a significant innovation then and an essential one if industrial organization were going to grow larger than the span of one person's control.

To prevent collisions on single-track lines that carried trains in both directions, railroad companies invented formalized operating procedures and the organizational structure and mechanisms required to carry them out. (ibid, p. 13)

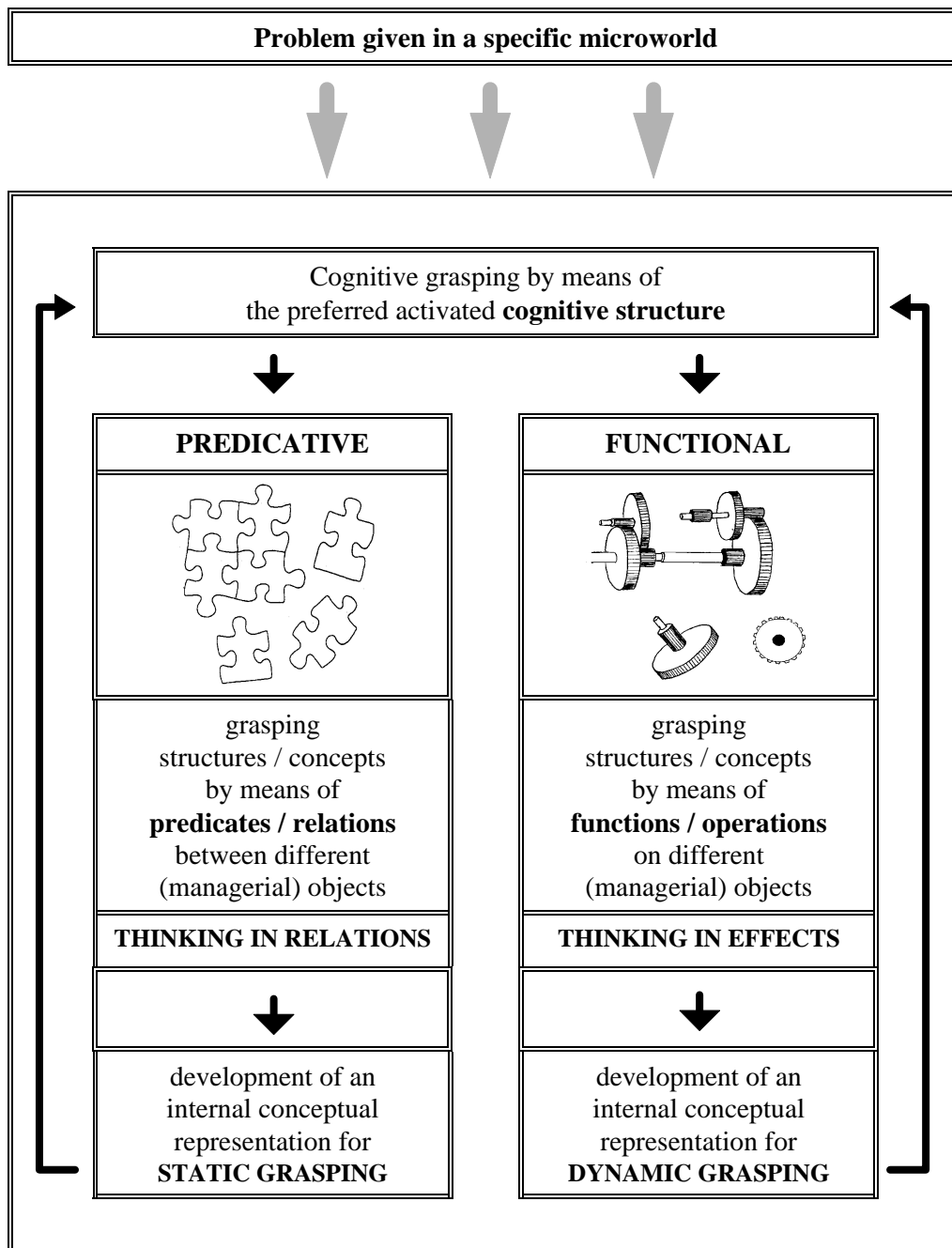
On the first approach it is an astonishing phenomenon: the running of trains seems to be a process-orientated business. But this example shows how the point of view determines the mental model. The invention of the block structure, i. e. only one train is allowed between two signals, reduces the process of the running train to the statement about single states, whether the train is inside the considered sector. Instead of organising processes one can handle facts in a static manner.

Hammer and Champy demand BPR to be radically changed when thinking about the organisation of a corporation. There has to be a change from thinking in terms of structures and compartments to thinking in terms of processes. As a consequence BPR needs another mental organisational model. Hammer and Champy describe how managers should understand their job in organising the business processes, and who should be selected to start the reengineering. But we could not find any hint in their book of them being aware of the fact that stable individual differences exist in a way, whether processes are a genuine concept in the mental model or not. Our research deals with the question why many business people are not process-orientated. One important answer seems to be that it is not simply a matter of deciding to be process-orientated, but of the preferred individual cognitive structure. In the following we will explain why there is a need to consider individual differences in mental modelling and cognitive structures to better understand the benefits and failures of BPR.

### *Predicative versus functional cognitive structures*

The distinction between dynamic and static mental modelling as a characteristic of the individual cognitive structure - and not (e.g.) as a characteristic of the task - was introduced by Schwank (1986). She distinguishes between *predicative* and *functional* cognitive structures (Fig. 1). Predicative thinking emphasises the preference of thinking in terms of relations and judgements; functional thinking emphasises the preference of thinking in terms of courses and modes of action (cf. Schwank 1993, p. 209). For an overview of the experimental testing of the theory see Schwank (1995, pp. 108 - 115). It is also reported that it is quite rare to find female students who behave in a functional way (see also Schwank, 1994).

The given diagram (Fig. 1) has to be read spirally in chronological order. The arrows describe circles in order to consider that the internal tools of the conceptual representation influence that which will be grasped cognitively. This will influence the further development of the internal conceptual representation. The observed differences in behaviour are explained in such a way that not both kinds of cognitive structures are not applied equally. A different development of a more static or a more dynamic internal conceptual representation will therefore be undertaken which the special kind of grasping explains.



**Fig. 1:** Predicative versus functional cognitive structures (cf. Schwank 1995)

The category of individual cognitive structures has to be separated from the category of individual cognitive strategies. We distinguish between a conceptual, top-down organising, and a sequential, more interactive approach (Cohors-Fresenborg & Schwank, 1996). Predicative / functional refers to the tools of thinking, conceptual / sequential refers to the global organisation of the problem-solving process.

In Cohors-Fresenborg & Schwank (1996) we have analysed several examples given by Hammer & Champy (1993) through the lenses of our cognitive theory. In the following we will present some of them.

Work that requires the cooperation and coordination of several different departments within a company is often a source of trouble. (ibid, p. 9)

Too many handoffs exist ... Each handoff entails queues, batches, and wait times. ... Once an order enters the process, it might as well be lost until it emerges at the other end - whenever that might turn out to be. (ibid, p. 27)

The steps in the process are performed in a natural order. ... In reengineered processes, work is sequenced in terms of what *needs* to follow what. (ibid, p. 53/54)

Nonetheless, one of the most frequently committed errors in reengineering is that at this stage reengineering teams try to analyze a process in agonizing detail rather than attempt to understand it. (ibid, p. 129)

In the case of functional thinking, the concatenation of processes is a basic concept. Hence we interpret the above quotations as a promotion of functional thinking. The problem of handoffs (handovers) in concatenating processes is a crucial one. Let us take a 4 x 400 m relay race as a metaphor for analysing this point. In the predicative field of vision the handover of the baton is always at the same place in the same co-ordinates. In consequence a trainer should teach each member of the team to know this fact and to be able to hand the baton over as exactly as possible at these co-ordinates. But obviously this is not what we wish to manage. In the functional field of vision the problem is the synchronisation of two motions. In consequence the training should be rather different from that based on predicative reflections. The training has to improve the performance of the team to synchronise the motions during the handovers.

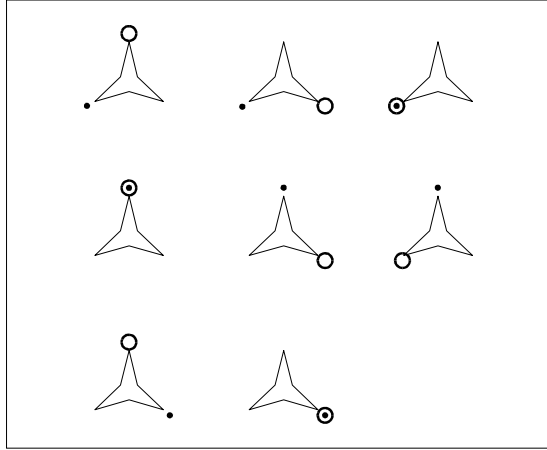
## 2. Pilot studies

If we follow the analysis of Hammer and Champy, as already described, there is a great difference in the mental model concerning the task of an organisational problem: For a predicatively structured person the central point of his or her analysis concerning a complex situation is to break it down into different conceptual pieces and to invent a logical structure which describes the network of the relations between these pieces. For a functionally structured person the central point is to arrange the going through the production (or the bureaucracy) as a complex process in which different strengths control, determine or promote each other. For the former the mental model describes the logical structure, for the latter it describes the organisation of work flow in time.

To show the benefit of our cognitive theory for a cognitive approach in business reengineering we have designed a pilot study which is run with single subjects consisting of three parts: fitting figures in matrices (QuaDiPF), organising processes in a microworld (OPM), interview on managerial behaviour (IMB). QuaDiPF (Schwank, 1997) is a qualitative diagnostic-instrument to determine the preferred cognitive structure, predicative versus functional. In OPM those tested have to solve a sequence of organisational problems with the specific microworld Dynamic Mazes (cf. Cohors-Fresenborg, 1978). We know from other studies that this setting in the beginning supports the functionally structured subjects. For solving the more complex problems a predicative cognitive structure is more successful. In IMB we interview the subjects about their management behaviour, the goals which they are aiming for and the way in which they represent management problems in their mind. At the end of the interview we confront the subjects with differences in their problem-solving behaviour between the construction in OPM and their own discussions about their points of view concerning their management behaviour in their business.

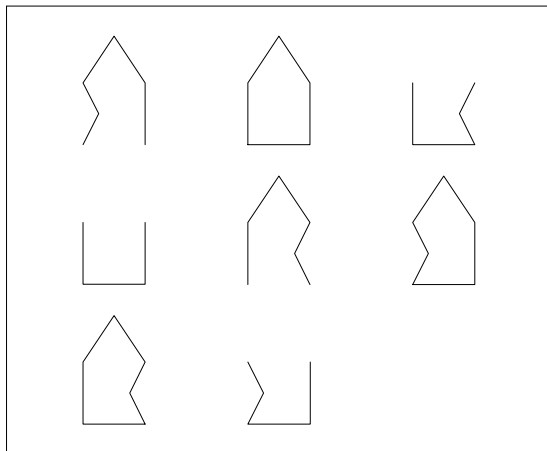
## 2.1 Fitting figures in matrices: QuaDiPF

We use tasks such as those in common intelligence tests (e. g. Raven, 1965) to find a missing figure, which fits suitably into a set of 8 given figures arranged in a matrix. In a clinical interview each subject has to invent and draw the missing figure in the matrix (instead of selecting it from a given set as usual). The subject has to argue why he or she drew this very figure.

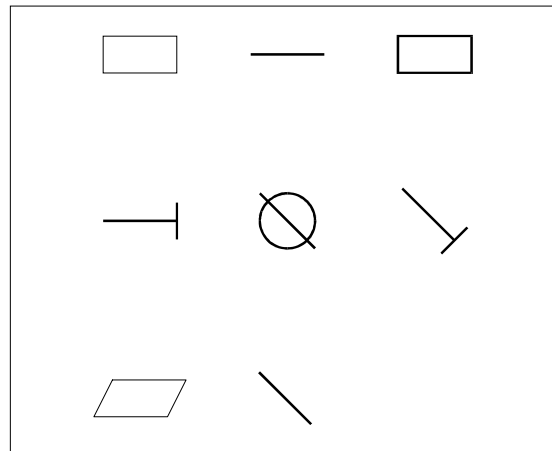


**Fig. 2a:** QuaDiPF-Example (Schwank, 1997)

The analysis of the videotapes shows that a predicative and a functional way of mentally modelling the task exist. In a *predicative* mental model the subject uses predicative tools, e.g. looking for properties, inventing a general law. So, in the given example (Fig. 2a) the subject tries to structure the image. Each figure consists of three objects: a star, a point and a circle. The triangle is the same in each figure. In each row the point is at the same place. In each column the circle is at the same place. In a *functional* mental model the subject uses functional tools, e.g. invents a process which produces the last element in a row or column. In each row the circle moves around, and in each column the point moves around. The object around which the movement takes place does not change. In both ways of dealing with the problem the result is the identical.



**Fig. 2b:** QuaDiPF-Example (Schwank, 1997)



**Fig. 2c:** QuaDiPF-Example (Schwank, 1997)

Besides tasks such as 2a we also invented tasks which are either easier using a predicative analysis or a functional one. Fig. 2b shows an example in which a predicative analysis is useful to construct a working mental model. The main idea is to invent a structure by arranging the properties. One could, for example, proceed as follows: three types of figures exist (closed figures, figures which are open at the top and figures which are open at the bottom) which each have straight walls, bent left walls and bent right walls. The figure with an open bottom and straight walls is missing (composition of predicates). Fig. 2c shows an example in which functional analysis is useful. The main idea is that the figures in the middle row and the middle column are names of operators. One could, for example, proceed as follows: in the first row the first figure is given thick lines by means of the operator. In the first column the first

figure is pushed by the operator and transformed into a parallelogram. In the second row the first figure has to be turned by means of the operator. In the last line as a consequence the first figure has to be turned and it has to be given thick lines (concatenation of operators).

We have designed the tasks in QuaDiPF in the form that the subjects have to explicitly construct the missing figure instead of selecting it from a given set of possibilities, for the following reasons: we are interested in thinking processes and the omission of possible solutions makes the tasks more difficult. Furthermore, we are interested in the individuality of problem-solving: a given set of possible solutions could influence the way in which the tasks are analysed. As a consequence our methodology is rather a qualitative one than a quantitative one.

In the literature it is discussed that solving this kind of task requires especially inductive thinking. The findings of Schwank show that not only one kind of inductive thinking exists. In a predicative model induction means abstraction. The result is a predicate which is fulfilled by the given examples. In a functional model induction means generalisation. The result is a function which produces the given examples (cf. Cohors-Fresenborg & Schwank, 1996).

## 2.2 Organizing processes in a microworld (OPM)

*Problem:* Let us consider that in a production process two different kinds of bottles are produced, called A and B, which occur on a conveyor belt in the sequence A B A B, etc. Your task is to construct a sorting machine which separates bottles A from bottles B. You are only allowed to use the following switch (Fig. 3a) and simple bricks (straights, left and right curves, crossings) to construct the path for the running bottles.

The task means that you can only use the knowledge concerning the order in the sequence of bottles for your problem solution (i.e. A B A B, etc.), and no any other knowledge concerning the specific bottle which is just entering the sorting machinery (e.g. by reading the label).

Let us assume that in the beginning the switch is in such a position that the left path is open. Let us also assume that the distance between the bottles is large enough so that the next bottle only enters the switch after the bottle has reached the goal box.

Most of the subjects will first connect the conveyor belt carrying the bottles to the main entrance of the switch (Fig. 3b). The given problem has to be reduced to the question of how to arrange the flow of the bottles through a network so that the two paths of the switch are reached alternatively. Following this idea one may concentrate on the question of how bottle B can reach the right branch if bottle A has passed the left one.

In pilot studies with young adults we could show that *predicatively* structured subjects have great difficulties in analysing this situation in a way that the suitable path for bottle B is not like a property of bottle B, but that bottle A has to start a process which arranges the change of the path for bottle B. This means that during the reflection of the suitable path of bottle A, one has to anticipate that the following bottle B has to follow another way. This anticipation of a later situation, which has to be arranged now, is the crux of the problem. In comparison to the difficulties of predicatively structured subjects it is quite easy for *functionally* structured subjects to make the mental change from „bottle B has to go on the right path,“ to „I have to arrange something with bottle A so that bottle B reaches the other path in consequence,“ after just a short time. This conceptional change is the break through for finding the next step in the solution, as Fig. 3c shows.

If a subject analyses the machine described by Fig. 3c, he or she detects that the first bottle A reaches the exit on one side, bottle B reaches another exit, but unfortunately the same exit will be reached by all the other following bottles. It is no problem to detect that there is now a

similar situation to before. But it is interesting to observe that a lot of subjects exist who see and describe this similarity, but are not able to quickly arrange the suitable solution as described by Fig. 3d. Predicatively structured subjects may be able to detect the structure in the problem and to verbalise it, but are very often unable (or need an astonishing amount of time) to invent the necessary path for the flow of bottles, especially in the case when they did not solve the first part of the solution (i.e. the suitable path for the first bottle A), but needed a lot of hints by the observing interviewer.

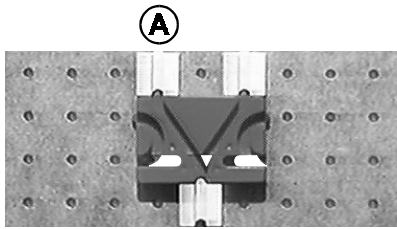


Fig. 3b

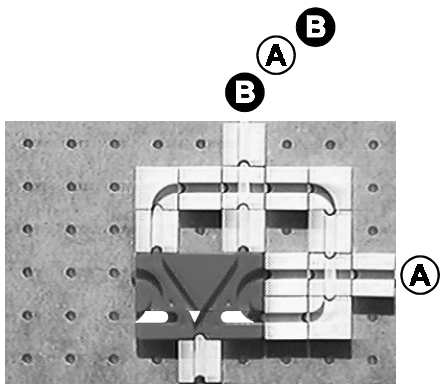


Fig. 3c

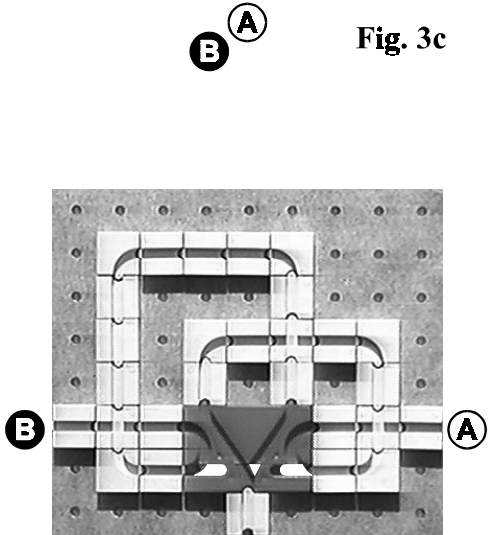


Fig. 3d

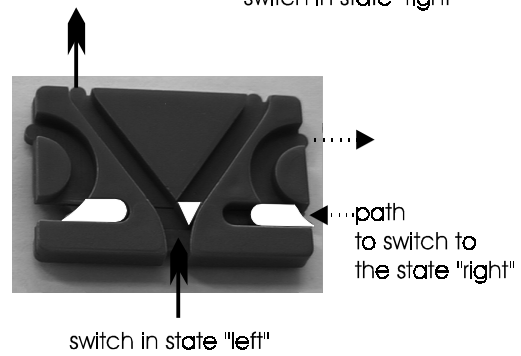
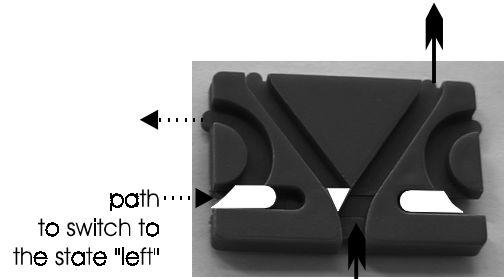
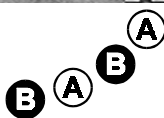


Fig. 3a: Main brick: switch

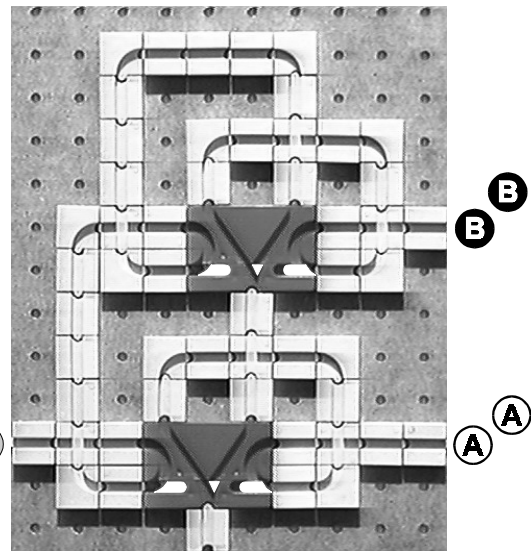
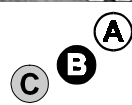


Fig. 3e



One may offer the following description of the behaviour of the predicatively structured subjects: They are able to analyse the given problem on an abstract level, but are unable to carry it out in a concrete situation. We cannot agree to this description because the special issue is not a matter of the difference between abstract and concrete. The subjects have the concrete bricks in their hands, a model of bottle B, but nevertheless they are unable to invent the *anticipation* of the next situation.

After that first problem (if subjects cannot solve it by themselves, we give a series of well prepared hints so that at the end they are successful) we offer them the following problem: Let us assume that on the conveyor belt there is an ordered sequence of bottles A B C A B C, etc.. You have to invent a sorting mechanism to separate the three kinds of bottles. You are allowed to use more switches if you like.

In our pilot studies we have observed that predicative subjects analyse the problem quite early in the way that they declaim a similarity to the first problem. By similarity they mean that sorting the three bottles consists of two sorting activities: either first separate bottle A from the following stream of the two bottles B and C, and then separate the flow of B and C into the flow of B and the flow of C, or first let the flow of A and B pass and separate the following bottle C, and then separate, in the flow of bottles A B A B, the bottles A from the bottles B. Then they declaim that for the different sorting processes solutions do exist (either they have found them by themselves after some time or they have learnt it after heavy hints from the interviewer). In the following they try to construct partial solutions for the separated subproblems using the previous solutions. If the subjects are intelligent enough and are encouraged enough by the interviewer, they find the solution (Fig. 3e) in a reasonable time period.

But it is very astonishing to observe the behaviour of many functionally structured subjects. Very often they do not say that the problem is similar to the first one, but that it is more complex. They start again by inventing the partial solution (Fig. 3c), test it with the flow of bottles A B C A B C, find a similar argumentation to arrange the switch for the flow of B and C during the running of bottle A as before. But then they have the problem of how to continue the process of sorting. They make different attempts of solutions, their verbalisation describes that they have to arrange it in a better way, or they try to arrange the anticipation earlier than they did in a failed solution. Very rarely they try to use some insight into the static structure: to use the two bottle sorting machine (which they have solved in the first problem) as a new object or a module for the more complex solution. It seems that they always try to organise simultaneously the sorting process of the three bottles and that they have difficulties in breaking it into two pieces, as Hammer and Champy describe the main issue of bureaucracy (cf. the citation of Hammer & Champy/p. 13 in our introduction).

### **2.3 Interview on managerial behaviour (IMB)**

We had the opportunity to make some case studies with subjects who belong to the middle management group. We asked them how they plan their management decisions, what is important considering their business processes, which categories are responsible for failure and in which directions they try to develop their organisational surroundings.

It is not astonishing that managers, who we analyse by means of QuaDiPF/ OPM as preferring a predicative cognitive structure and a conceptional top down way of problem-solving, declare that the main issue of analysing a given problem means to find a common structure, to break a big problem into pieces and to determine the relations between these subproblems.



But we were quite astonished when we found the following behaviour: Managers who prefer a functional cognitive structure and an interactive problem-solving style in the situations QuaDiPF/ OPM, but who report about the principles of their organisation and their behaviour in management situations in a way which we classified as using a predicative mental model and a top down problem-solving strategy. After we had carried out that part of our interview we confronted these managers with the discrepancy between their own behaviour, which they had demonstrated in our two investigations, and their verbal description about their behaviour in every-day management. They gave us a very interesting answer.

They agreed to our interpretation concerning their preferred cognitive structure, used mental models of the problems and their individual problem-solving behaviour, they agreed with our statement that their reports concerning their every-day management behaviour did not fit to the behaviour which they had shown in our problem-solving situations and then they gave a very astonishing explanation: When they talk about their managerial behaviour they obviously behave according to how they are trained and to the social expectations demanded in the corporations: predicative modelling combined with top down organised problem-solving. We then asked them why they did not use this behaviour in our problem-solving situations. And again we were quite astonished about their answers: They felt a lot of stress when we were observing their personal competence and recording it with video tapes, so that they were forced to give their best in such an important situation.

We asked them why they did not feel stressed in their every-day managerial situations. And then again they gave a very astonishing answer: If they really try to solve a problem and they feel that this is important for themselves, these functional and interactive managers - even in their managerial situation - behave as they behave in our tasks. They declared very openly that we had detected their personal mental and problem-solving structure. But our questions in the interview concerning their managerial behaviour were understood by them in the same way as the questions from upper management concerning their managerial behaviour are understood by them when they report: There is a kind of a social contract in management, how to be a good manager and therefore these subjects have to look like good managers, but in the stress situation they behave as they are in agreement with their personality.

In the last part of the interviews we asked these subjects how they felt in such a „double personality“. The answer was that, of course they sometimes feel forced to be dishonest. But after such a long time of training and managerial life they are acquainted to this situation. They have learnt that a top down problem-solving structure and a precise analysis of the (static) structure of management categories and relations is the „better“ way of doing the job. On the contrary, they regard their own different behaviour in „emergency situations“ as justified by that situation and by their success. But their report about theoretically „good“ management follows the social conventions.

### **3. Conclusions**

Our analysis (see also Cohors-Fresenborg, 1996, Cohors-Fresenborg & Schwank, 1996) of the ideas of Hammer and Champy (1993) concerning the radical change in business process reengineering led to the hypothesis that one explanation in the reported difficulties to adopt Hammer and Champy's idea in the reengineering process is that they demand the utility of a functional mental model of business processes. They demand a new point of view. The theory and experimental testing of the theory of Schwank concerning individual differences in preferred cognitive structure has shown that there is a stable preference for either a predicative or a functional cognitive structure. If we consider the given situation and the intended changes in managerial behaviour there are the following difficulties: The personal preferences in mental

modelling the business processes (predicative versus functional) and the individual preferences for problem-solving strategies (conceptional versus sequential) interact with the given management culture and structure in the corporations. Hammer and Champy give an analysis of the culture in the North American corporations, which we would describe in our theory as a preference for a predicative description connected with a top down problem-solving strategy. The reported difficulties in changing the corporate managerial culture can be explained by the hypothesis that very often the managers' personal mental models fit with the practised managerial culture, but will not fit with a change as demanded by Hammer and Champy. Therefore these managers will only change the surface and the vocabulary, but they are unable to change their mind and their behaviour. The result is the low success of those business reengineering projects. Our case studies suggest that this is a suitable analysis but this hint comes from the opposite direction: The functional managers we interviewed have survived in a static bureaucratic management culture up to now. Therefore they adopted the required vocabulary and the behaviour which can be observed from the outside, but of course they did not really change their own mental processes. The chance for business reengineering projects in the spirit of Hammer and Champy could be to detect functional managers who prefer a sequential strategy and first allow them to behave in the public of the corporation as they would like to behave in the private atmosphere of their own thinking processes. That means destroying the general preference which is given to structural analysis and top down organisational procedures. It would give those functional and sequential managers the freedom to follow their own personal beliefs.

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