



# Stop chasing the Front End process — management of the early phases in product development projects

Dennis Nobelius\*, Lars Trygg

*Department of Operations Management and Work Organization, Chalmers University of Technology, S-412 96 Gothenburg, Sweden*

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## Abstract

The early stages of the product development process have drawn a great deal of attention over the past few years. Prior research has especially singled out these early activities in the pursuit for competitiveness in the future. Previous research, as well as practitioners, has focused on a number of different issues related with the early phases. This has, though, all been done with the underlying aim to develop *one* optimal process for the opening stages (often referred to as the fuzzy Front End). This paper questions the appropriateness of the current working methods and process work by analyzing the early phases to determine the appropriateness of using one Front End model. Three development projects with different characteristics have been empirically explored in this study. The projects studied showed differentiated Front End processes with respect to activities performed and task sequences, as well as relative time duration and perceived importance of individual tasks. Hence, the findings indicate that there is less use chasing and mapping out *the* Front End process applicable for the pre-project phase. The findings indicate the need for more managerial flexibility in the pre-project phases. Flexibility is needed in the form of staffing, priorities, and advanced planning of activities. The findings further reveal the need for early on choosing several proper Front End routes, later to be screened, communicated and shared. A basic model to assist a suggested Front End team in this process is proposed. © 2002 Elsevier Science Ltd and IPMA. All rights reserved.

**Keywords:** Front End processes; Product development

## 1. Introduction

The increasing pace of product introductions combined with less acceptance regarding mistakes and misdirected efforts leads to a greater need for a correct procedure the first time. The opening stages of the product development process are by many researchers considered a “fuzzy area”, being a vital element when trying to gain competitive advantages in the 1990s [1–4]. Several surveys have been conducted in order to validate the importance of the opening stages, often referred to as the Front End [6–9]. The existing findings indicate the Front End process as having the largest potential for improvements at the least effort possible [4,10].

However, the state of science strongly pursues the development of *one* Front End process, analyzed and mapped without concerns regarding type of industry or

project characteristics [4]. This is in line with the industrial attempts as well, for example, Clausing (1994) is discussing Xerox and the existence of a Front End process [11]. These activities and their proposed relative sequences are mapped out, and recommendations of how and when to proceed with the elements are given. Khurana and Rosenthal have, for example, described the early stages of transforming the company strategy into new products as consisting of three phases: Concept statement and evaluation, Product definition and the Project-planning phase [12]. Cooper similarly has defined the Front End as Idea generation, Preliminary Assessment and Concept Definition [7]. The existing descriptions of the Front End all aim at developing one Front End process, the question asked in this paper is to what use, and how applicable is this ‘general model’ of the fuzzy Front End.

### 1.1. Frame of reference

The frame of reference argues that existing descriptions of the early stages of new product development

\* Corresponding author. Tel.: +46-31-7725233; fax: +46-31-7721194.  
E-mail addresses: dennis@mot.chalmers.se (D. Nobelius), latr@mot.chalmers.se (L. Trygg).

basically aim at developing one Front End model, and that the existing Front End models are similar in nature with respect to number of phases, activities, content and context. Furthermore, there is a lack of descriptions of situational factors and of managerial advice of how to actually manage the fuzzy Front End.

#### 1.1.1. The early phases of new product development

The term Front End in this paper refers to activities performed before the actual start of the project (pre-project activities). A comparison between one of the first research models [7] and one more sophisticated model [12] is also analyzed in order to give the spectrum.

There are a few detailed models or descriptions of the early phases, each describing a similar setup. One of the earliest attempts was based on surveys regarding success and failure studies conducted mainly in the USA during the late 1970s [7]. Cooper identifies three major steps in the pre-project phase: Idea generation, Preliminary assessment and Concept definition (Fig. 1.).

Cooper's three-stage sequence is, in its simplicity one of the most referred models of the pre-project stage. Idea generation involves conceptualization of the product idea and Preliminary assessment the process of defining the winning product — its positioning, associated benefits, and product design. Finally, the Concept definition estimates the likelihood of development and market success. Smith and Reinertsen prefer to call these pre-project stages "*The Fuzzy Front End*" [13]. Smith and Reinertsen claim that the early stages of a development effort are often neglected with regard to resources, attention and top management support due to vague objectives and lack of traditional project management time focus. Smith and Reinertsen's activities<sup>1</sup> are similar to Cooper's rough model, and are likewise lacking in specific context. A more recent attempt at refining this 'general' Front End model is done by Khurana and Rosenthal [12]. They examined 11 companies, sited in USA and Japan, involved in incremental innovations, and focused on the integrational difficulties related to the Front End of new product development. They refine the model by stressing the existence of project-specific elements and non-project-specific elements (called foundation elements) and their inter-relationships. The foundation elements are given at the time when the Front End process starts, and they are more or less rigid over the project time. A typical example of a foundation element is the portfolio strategy. An example of a project-specific element is the proposed product concept. They aim at presenting the Front End process as consisting of the following project-specific elements;

Preliminary opportunity identification, Product concept and definition, Project planning.

Consequently, as presented, there exist a number of slightly different Front End models; choosing one model is difficult due to different use of language, contexts, etc. A brief analysis of what the Front End process transforms and delivers leads on to a synthesis characterizing the Front End process; a model later used in the forthcoming study. All models require some kind of strategic planning input [11,14] linked with an opportunity recognition [14]. Regarding the output, the Front End process seems to provide a plan for the forthcoming project [3,11,14,16,17] together with a Concept specification [3,11,14,18]. A synthesis of all the proposed activities of these models reveals the following elements of the Front End process: Mission statement, Concept generation/screening/definition, Business analysis and Project planning (Fig. 2).

These activities are to be seen as a synthesis of the descriptions in the current literature of the early phases, and they will be used when analyzing the different projects. Further, it can be concluded that the synthesized model covers the described models with the exception of Khurana and Rosenthal's specific foundation elements [12].

It is worth noticing that Khurana and Rosenthal in their latest follow-up article, based upon the same empirical data, discuss the importance and need of adapting the Front End process to the product, market and organizational contexts of the firm [19]. However, they do not discuss the existence of different types of development tasks or projects within the firm and their possible different needs and demands on the Front End process. In fact, the only additional discussion about contextual factors, i.e. having different Front Ends, is found in Reinertsen [9]. Reinertsen's example of a two-track Front End process is differentiated due to the different time focus the projects have. Reinertsen's two Front End processes differ depending on whether the activities are conducted in sequence or in parallel, arguing that time-focused projects should be conducted in parallel (Fig. 3). The trade-off decision deals with the benefit of gaining time, and the cost of conducting a time-focused project.

Concluding, the state of science aims at developing one Front End of product development. A synthesis of this model is captured in Fig. 2.

#### 1.1.2. Research question

The importance of performing well at the Front End of new product development is not questioned in this study — several research studies are evidence thereof. The analysis concludes that the state of science, as well as practitioners, pursue the search for one single model of the Front End. Hence, the aim of this paper is to explore and contrast different pre-project phases and

<sup>1</sup> Opportunity identification, Idea generation and selection, Market acceptance and Business opportunity analysis, Product planning and finally Planning for financial and human resources

their applicability to one more general Front End model, developed by synthesizing previous research.

### 1.2. Methodology

The novelty of the research area motivated an explorative case study to ensure correct interpretations of the Front End processes in the firms that have been analyzed [20]. The choice of projects highlights the question about how different Front End processes might differ with respect to development tasks, priorities, and management needs.

Three different R&D projects were chosen. The underlying aim is to describe and analyze these in light of the proposed, synthesized Front End model. Choosing three projects represents a deliberate trade-off between depth and width, however, following the explorative aim of the study; in-depth analysis of three

projects ought to be enough for an initial test. The projects were selected from two Swedish manufacturing companies: one research-like project in a large automotive company, one more incremental project, and one project aiming at developing a new platform in a medium-sized company. Thus, there was an opportunity to study how the Front End stage really appears in those three types of projects.

The data was mainly collected by questionnaires, by attending project meetings, analyzing internal company documents and by conducting open-ended interviews with people being active during the pre-project stages, especially the pre-project leader. Moreover, approximately 70% of all project meetings in the Platform project case have been attended throughout the study in order to gain understanding of the company context. Considering the automotive firm, approximately 25 interviews with managers from different departments

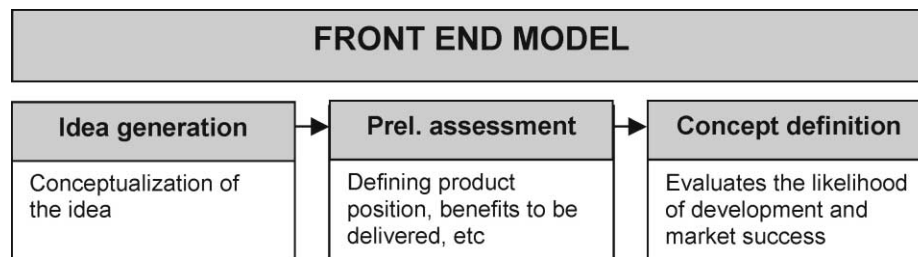


Fig. 1. Predevelopment activities according to Cooper [6].

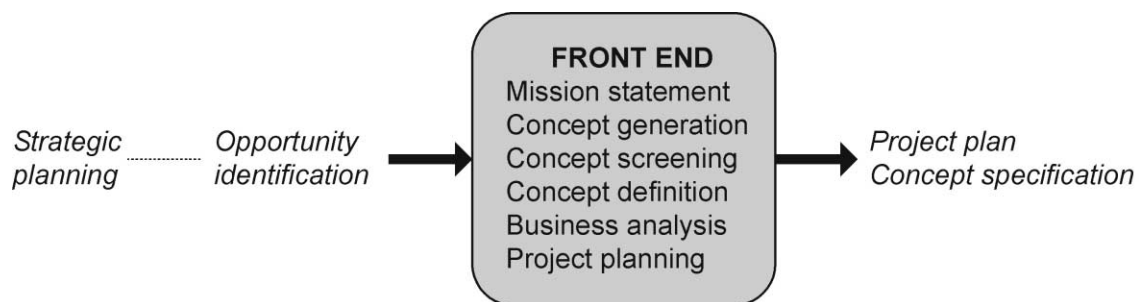


Fig. 2. A synthesized input, activities, and output description of the Front End.

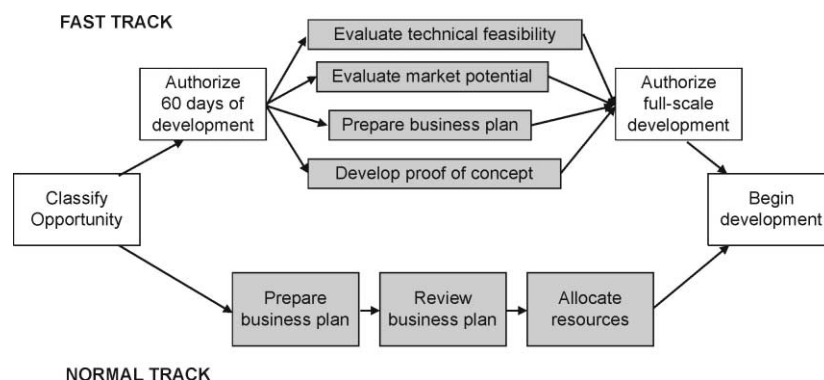


Fig. 3. Reinertsen's two-track Front End process [9].

Table 1  
Priority and weighted importance of Front End activities according to pre-project leader

Activity	Priority	Weighted importance
<i>Mission statement</i>	5	10
<i>Concept generation</i>	2	10
<i>Concept screening</i>	2	20
<i>Concept definition</i>	1	50
<i>Business analysis</i>	—	—
<i>Project planning</i>	2	10

active during the early stages of product development were made before the study commenced. Hence, there existed basic knowledge about the company before the study was initiated. The access to company data has been generous, thus enabling an interpretation of the company activities conducted into the same terms of language. This has allowed a proper comparison between the three projects.

In order to capture priorities, perceived importance and staffing of conducted activities a questionnaire was used. The questionnaire was based on the literature survey and was handed out personally to the pre-project leaders after the conducted pre-study. The different terms used in the questionnaire (Fig. 2) were discussed and the pre-project leader was given the opportunity to ask questions while completing the questionnaire. For example, the individual ranking as well as weight were asked for and explained. The individual weights were asked for not only to reveal the ranking of the activities involved, but also the individual importance. The respondents were able to answer the questions without any problems with one exception regarding one specific question — one of the pre-project leaders had difficul-

ties prioritizing and weighting the different Front End activities (Table 1). The chosen Front End measurements are based upon Slack et al.'s transformation model [15], i.e. the time duration of activities and their sequences, as well as staffing resources and input/output were investigated. All time measures have been scaled for reasons of confidentiality.

### 1.3. Empirical findings

In this section a brief overview of the studied projects is given, followed by a more detailed description of each project. Finally, a comparison between the projects is made. Three different projects were chosen: a research project, an incremental project and a project aiming at the development of a new platform. These projects were carried out within two Swedish manufacturing firms, one large automotive company and one medium-sized printer manufacturer.

#### 1.3.1. Company and projects overview

Both companies have been established in their industries for decades and operate in the global market. The printer manufacturer has mainly grown by means of mergers while the automotive company has mainly grown organically. They differ significantly in company size; the printer manufacturer has approximately 200 employees while the automotive company has approximately 20,000 employees. The product life cycle is continually shrinking, but the current life cycle of a product from the printer manufacturer is 7 years compared with approximately 15 years for the automotive company. Furthermore, it takes approximately 18 months to develop a new barcode printer and 5 years for the automotive product. In Table 2, some additional char-

Table 2  
Characteristics of the three studied projects

Characteristics	Research	Platform	Incremental
<i>Company</i>	Large manufacturer in the automotive industry	Medium-sized manufacturer for printers	Medium-sized manufacturer for printers
<i>Project mission</i>	Evaluate a hybrid concept	Replace the existing product generation	Develop a new module for the printer scissors
<i>Organization</i>	Consortium: Internal personnel/ Consultants	Internal personnel + mechanical consultants	Internal personnel + mechanical & electrical consultants
<i>Key technologies</i>	Mechanical, electrical- and electronic, hydraulic engineering	Mechanical, electrical- and electronic engineering	Mechanical, electrical- and electronic engineering
<i>Pre-project duration</i>	5 months	6 months (2 man-years)	1 month
<i>Development project duration</i>	20 months	18 months	5 months
<i>Pre-project participants</i>	4	11	5
<i>Cross-functionality in pre-project</i>	None	All major functions represented	None
<i>Cross-functionality in development project</i>	All major functions represented	All major functions represented	None

acteristics of the three projects in the two companies are given.

The project mission for the Research project was to develop and evaluate a new hybrid concept, for the Platform project the replacement of the existing product generation was in focus and for the Incremental project the mission was to develop a new module for the printer scissors. The projects were mainly mechanical, with the exception of the Research project whose key technology was electrically based.

### 1.3.2. The research development project

The automotive company developed a complete concept vehicle a few years ago. One of the spin-off effects of that vehicle was a new type of hybrid power train. In order to further develop and test the technology, the development of a new concept vehicle focusing upon the hybrid power train was decided on. The project was therefore mainly technology push driven, i.e. a strategic project with currently no market demand. The input to the project was mainly data from the former concept vehicle. The output consisted of a system specification and a project plan. The performed activities and their sequences are presented in Fig. 4.

It is worth noticing that the project started before the Concept definition phase was due and that the Business analysis phase occurred after the project was completed. Moreover, there were two Go/No go-gates during the project — one after the Concept generation phase and one after the Project planning phase. The parallel Concept definition and project phase was an admitted mistake among the team, next time they will aim at finishing the definitions before the actual start. The late Business analysis phase is, however, more related to the research project characteristics, the aim of the project is to develop a concept that is later going to be analyzed as a business proposal. Furthermore, the project was externally financed and included in the contract for the former vehicle.

The persons involved in the pre-study were the R&D Manager and two R&D Consultants (Table 3). However, it should be noted that a brainstorming session was held

Table 3

Time and resource allocation of performed activities

Activity	Time Units	Number of Persons	Participants
<i>Mission statement</i>	1	1	R&D manager
<i>Concept generation</i>	60	2	R&D consultants
<i>Concept screening</i>	60	4	R&D manager, R&D consultants
<i>Concept definition</i>	60	7	R&D manager, consultants, project leader, R&D engineers
<i>Business analysis</i>	—	—	—
<i>Project planning</i>	90	3	R&D manager, R&D consultants

The activities were carried out during a period of 5 calendar months

involving 12 employees (mainly the forthcoming team members and one invited university professor).

The pre-project manager was asked to rate the activities from 1 (most important) to 6 (least important), but the manager had problems prioritizing. The manager therefore rated three of the activities as equally important (Mission statement, Concept generation, Project planning), although the most important activity was the Concept definition phase.

### 1.3.3. The platform development project

The printer manufacturer has decided that their 7-year-old best-selling printer must be replaced within a couple of years. Furthermore, they decided to outperform the printer by themselves, introducing a completely new printer/platform for the same market segment. They also decided to try to decrease the cost and to improve performance. The printer manufacturer thereby stated the mission and initiated a pre-study, which was going to reach a product and market specification. The market pull was due mostly to the increased competition in the USA market. The 7-year-old technology used in the old platform product was also about to become obsolete. The processor, which the printer was based on, will not be available after 1998.

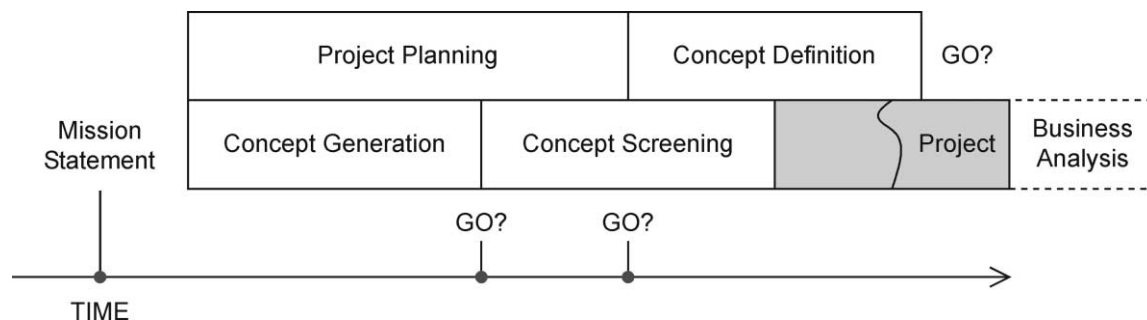


Fig. 4. Front End activities in the research project along a time axis.

Table 4  
Time and resource allocation of performed Front End activities

Activity	Time units	No. of persons	Participants
<i>Mission statement</i>	1	3	Product manager, R&D manager, Production manager
<i>Concept generation</i>	60	8	FOCUS GROUP: Product manager, R&D mechanical/software/electrical engineers, Manufacturing engineers, Purchasing, Technical support, Sales, Distributors, Customers, Operators
<i>Concept screening</i>	30	8	Product manager, R&D manager, R&D mechanical/software/electrical engineers, Manufacturing engineers, Purchasing, Technical support, Sales, Distributors
<i>Concept definition</i>	60	6	Product manager, R&D manager, Project leader, R&D mechanical/software/electrical engineers
<i>Business analysis</i>	60	4	Product manager, R&D manager, Production manager, R&D Project leader
<i>Project planning</i>	30	3	Product manager, R&D manager, R&D Project leader

The total of the time spent internally equals 2 man-years during a period of 6 calendar months

The pre-study involved 11 employees during 6 calendar months (Table 4). A total of 2-man-years were spent. However, these figures do not include the customers and distributors involved in the Concept generation or Concept screening group (which was conducted as a focus group). The internally involved persons during the pre-project phase and the approximate duration of each phase are shown in Table 4. Worth noticing is that the product manager and the R&D manager were the key persons during the pre-study. It should also be noted that the Concept generation phase received as much time as did Concept definition and Business analysis.

Of these activities Concept definition, Business analysis and Project planning were carried out in parallel (Fig. 5). The map is not to be viewed as anything else but a description of which activities were performed and whether the activities were conducted in parallel or not.

Furthermore, the importance of the activities performed during the pre-project phase is shown in Table 5, rating from priority one as the most important. Mission statement did not take much time to perform, but was rated as the most important activity during the pre-study. Concept generation and Concept screening rated lowest, although they make up more than 50% of the total Front End duration.

#### 1.3.4. The incremental development project

The printer manufacturer decided that their scissors in one of the printers must be replaced. Their current design is too expensive and the customers are not willing to pay the extra cost for a scissors module. The change is of an incremental nature and not considered particularly vital or time-pressured. The Product manager started the mission and initiated the work. The input to the Front End activities came from a market pull situation and the output was a prototype together with a technical specification.

The persons involved in this pre-study were mainly the product manager, R&D engineer and three consultants. The activity on which the resources were

Table 5  
Priority and weighted importance of Front End activities according to pre-project leader

Activity	Priority	Weighted importance
<i>Mission statement</i>	1	40
<i>Concept generation</i>	5	10
<i>Concept screening</i>	6	5
<i>Concept definition</i>	3	15
<i>Business analysis</i>	2	20
<i>Project planning</i>	4	10

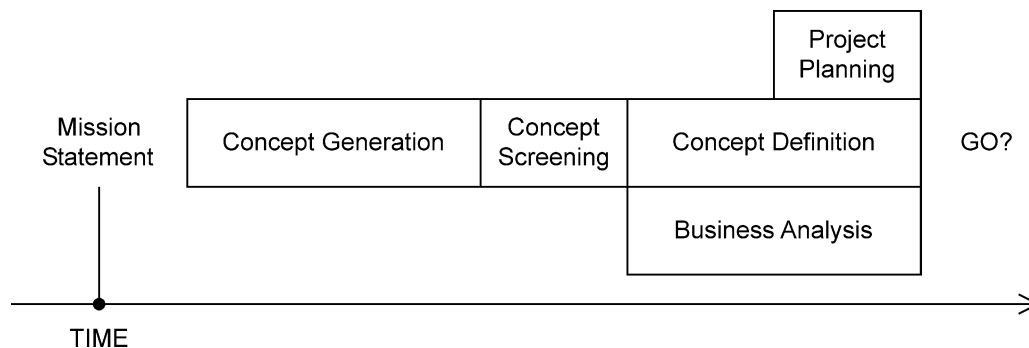


Fig. 5. Front End activities in the platform development project along a time axis.

Table 6  
Time and resource allocation of performed Front End activities

Activity	Time Units	Number of Persons	Participants
<i>Mission statement</i>	1	1	Product manager
<i>Concept generation</i>	15	4	R&D engineer, R&D consultants
<i>Concept screening</i>	5	5	Product manager, R&D engineer, R&D consultants
<i>Concept definition</i>	10	4	R&D engineer, R&D consultants
<i>Business analysis</i>	—	—	—
<i>Project planning</i>	15	4	R&D engineer, R&D consultants

The total of the time spent internally equals 3/4 man-year during a period of 1 calendar month.

focused was the Concept generation and Project planning phase and it is interesting to note that Business analysis received little or no attention. However, this is not too surprising when considering the incremental nature of the project — ‘incremental’ also implies ‘already knowing what to do’ (including constraints). The perceived needs for a Business analysis is infinitesimal, since the project, team knows the cost frames, and the necessity is already stated. Moreover, the program manager probably set up a rough early Business analysis before stating the mission.

Of the identified activities in the literature, it was only Business analysis that was not conducted within this Incremental project (Table 6). Moreover, Concept generation, Project planning and Concept screening were conducted in parallel (Fig. 6) The map is not to be viewed as anything else but a description of which activities were performed and whether the activities were conducted in parallel or not.

A priority of the activities performed is given in Table 7. The Mission statement phase was rated as the most important activity to be performed within this incremental project. The relatively weighted importance was as large as almost half of all the points spent (40 out

Table 7  
Priority and weighted importance of Front End activities according to the pre-project leader

Activity	Priority	Weighted Importance
<i>Mission statement</i>	1	40
<i>Concept generation</i>	4	10
<i>Concept screening</i>	5	5
<i>Concept definition</i>	3	15
<i>Business analysis</i>	—	—
<i>Project planning</i>	2	30

of 100). Project planning was seen as the second most important activity. The reason might be that much data and many constraints are already given — the main question is whether or not to start the project and if the resources are available or whether it is possible to conduct the project at all. The least important element was the Business analysis, which is somewhat surprising. A possible explanation is that when a mission is stated the importance is undoubtedly combined with the relatively low risk associated with Incremental projects. There are no radical results that are to be yielded from the Business analysis.

## 2. Conclusions and discussion

A summary of the three studied projects is given in Table 8. The gray areas within the “Priority” column indicate the activities that were conducted in parallel in the project (for more detailed information see related project descriptions). The Front End activities in the studied projects made up at least 20% of the total project time.

The findings show that there exists great variation in the Front End models of the studied projects (Table 8). Hence, no Front End process is equivalent to another with respect to set of activities, their sequences, degree of overlap, relative time duration and perceived importance of individual tasks. On the contrary, the findings indicate that there might be different Front End

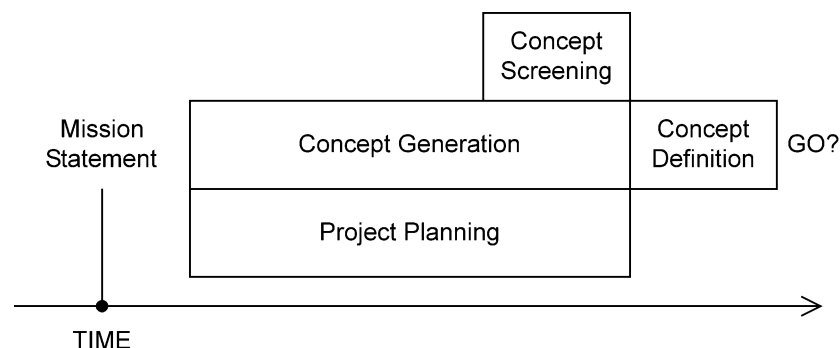


Fig. 6. Front End activities in the incremental development project along a time axis.

Table 8  
Summary of the Research, Platform and Incremental project.

RESEARCH			PLATFORM			INCREMENTAL		
Activity	Priority	# Persons	Priority	# Persons	Priority	# Persons	Priority	# Persons
<i>Mission statement</i>	5	1	1	3	1	1		
<i>Concept generation</i>	2	2	5	8	4	4		
<i>Concept screening</i>	2	4	6	8	5	5		
<i>Concept definition</i>	1	7	3	6	3	4		
<i>Business analysis</i>	—	—	2	4	—	—		
<i>Project planning</i>	2	3	4	3	2	4		

processes to be considered (concerning type of project) when trying to structure the early phases of product development. This ought to change the working methods of both process managers within the companies as well as for the academia. It seems to be less valuable to chase one Front End model; instead, a greater flexibility might be needed. This finding implies that in management, it is no use developing a single static Front End process and then implementing the process in all development projects. Hence, it is worth consider several co-existing Front End routes and to be able to deal with the flexibility.

When analyzing the projects a bit further, the Incremental project showed the simplest Front End model with respect to time duration, number of persons involved and number of activities, focusing on Project planning as a vital element to be conducted. The most important activity for the Platform project was the Mission statement. That project also devoted a great deal of time to generating different concepts. The Research project stressed the importance of a completed Concept definition phase before the Project actually starts.

In all of the three projects, the pre-project leader stressed the importance of one activity by weighting it very high (with almost half of the points available). This might indicate that of the different Front End activities there is one of them whose execution is regarded by the

project leader as far more important than the others. For the Platform and Incremental projects, there was the Mission statement activity and for the Research project there was the Concept definition phase. There is a risk associated with focusing on one of the Front End activities, Cooper stresses the importance of proficiency in predevelopment activities and emphasizes the danger of avoiding any vital activity [10]. Khurana and Rosenthal similarly claims that the Front End activities are to be seen as interrelated, and avoiding one of them contributes to project failure [9]. If then, the project leader focuses on one activity, do the other activities not risk being poorly executed? On the other hand, since the reflection is made in retrospect, was the higher priority a result of the project leader's post-project learning? Did one of the activities in retrospect seem more important than the other activities? This was probably the case in the Research project; notice the high weights on the Concept definition phase and the parallel execution of the definition phase with the actual Project (Fig. 4). Future studies should include interviews with pre-project members in order to verify such a hypothesis. The implication for management is that there is a risk of focusing too much on one Front End activity on behalf of the others. As mentioned earlier by Cooper, the whole chain of activities contributes to the pre-project proficiency [10].

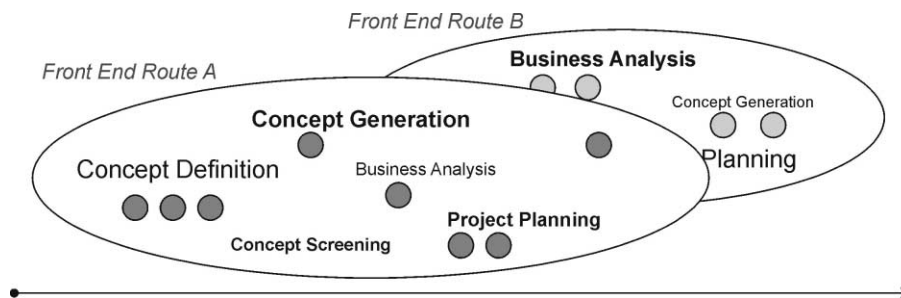


Fig. 7. Schematic Front End framework describing different activities, their potential sequences and relative priorities, as well as enabling a more flexible perspective of different Front End routes.



From the summary (Table 8) it is clear that the Front Ends in the studied projects differ not only with respect to activities but also to priority, sequence and importance. For example, the Mission statement is rated as the most important element in both the platform and in the incremental project, but as the least important in the research project. In addition, the Business analysis activity was rated as the second most important element in the platform project, but did not even occur in the other two projects. None of the projects carried out the activities in a similar sequence, nor did they parallelize the same activities. It can be concluded that Front End activities and their sequences seem to differ, i.e. to be more project-specific than the current state of science assume. Hence, it is questionable if it is wise to adapt one single front end model to different types of projects, working under different kinds of management logics, instead, a greater flexibility and variety seems to be necessary.

Future studies might include other kinds of projects in order to verify this hypothesis. They should furthermore include several projects with similar characteristics in order to find out if they also differ. It would also be interesting to look into what other factors, besides the type of development task that might affect the appearance of the Front End. How would, for example, technology push or market pull, allocated resources, management style, etc., affect the execution of the Front End activities? Future research might also take into account how these different Front Ends are managed and what the driving forces are for choosing among approaches. Furthermore, how could a company benefit from treating the various Front Ends differently?

### 3. Managerial implications

The findings indicate that there is no use chasing and mapping out one Front End process applicable for all pre-project phase. Instead, more managerial flexibility in the start-up phase is sought.

There is clearly a need for adapting the Front End model according to the type of project, staffing situation, and overall company situation. For example, a derivative project is depending on a sound business analysis to even be considered, while a business analysis might be a bit less vital in a research project. Hence, the Front End activities needs to be sequenced, prioritized and properly staffed depending on the specific context. The staffing situation is vital to consider early on for the pre-project execution. The necessary pre-project members needs to be signed up and committed for the expected required efforts. Finally, the overall company situation needs to be considered in the early phases, i.e. mapping other interfacing projects or strategies that potentially might affect the planning and execution of the pre-projects.

This advanced planning is suggested to be dealt with by a Front End team. In the studied projects, a mix of people (R&D managers, engineers, product managers) was used. The suggested Front End team ought to be cross-functional by nature and could, for example, be staffed by the forthcoming project leader, managers responsible for the monetary and personnel resources, the appointed key engineers, and persons representing the future (internal) customer. All with the underlying purpose to ensure a proper forthcoming transfer (See [21]), but also to ensure an agreement concerning resource management. This Front End team should also be responsible for identifying different Front End routes and to visualize as well as communicate these to the company community (Fig. 7).

Elements of a Front End route would include, as discussed before, Front End activities, priorities, sequences, and staffing. The decided routes are then to be communicated to top management, involved persons, and to the interfacing or linked projects. By discussing early on what activities to concentrate on when, and their individual priorities as well as the available resources, would indeed ease the project management and create a common view of the possible routes. Consequently, a customized Front End route is created each time for each individual project. The proposed Front End framework could assist in this matter and ensure that no vital activity is left aside (Fig. 7). Hence, the discussion in the Front End team ought to focus sequences, priorities, and staffing of possible Front End routes — instead of applying one pre-determined and rigid Front End process.

Concluding, the findings indicate the need for more managerial flexibility in the start-up and related attitude towards the pre-project phases. Flexibility is needed in the form of staffing, priorities, and activity advanced planning. The findings further reveal the need for early on choosing several potential proper Front End routes, later to be screened, communicated and shared.

### References

- [1] Cooper RG, Kleinschmidt EJ. Determinants of timeliness in product development. *Journal of Product Innovation Management* 1994;11(5):381–96.
- [2] Cooper RG. Predevelopment activities determine new product success. *Industrial Marketing Management* 1988;17:237–47.
- [3] Kumar V, Murphy S. The Front End of new product development: a Canadian survey. *R&D Management* 1997;27(1).
- [4] Verganti R. Leveraging on systemic learning to manage the early phases of product innovation projects. *R&D Management* 1997;27(4).
- [6] Cooper RG, Kleinschmidt EJ. Benchmarking firms' new product performance and practices. *IEEE Engineering Management Review* 1995;23(3).
- [7] Cooper RG. A process model for industrial new product development. *IEEE Transactions on Engineering Management* 1983;30(1).

- [8] Kumar V, Murphy SA. The role of predevelopment activities and firm attributes in new product success. *Technovation* 1996;16(8).
- [9] Reinertsen DG. Streamlining the fuzzy Front End. *World Class Design to Manufacture* 1994;1(5):4–8.
- [10] Cooper RG. *Winning at new products — accelerating the process from idea to launch*. 2nd ed. New York: Addison-Wesley Publishing Company, 1993.
- [11] Clausing D. *Total quality development — a step-by-step guide to world-class concurrent engineering*. New York: ASME Press, 1994.
- [12] Khurana A, Rosenthal SR. Integrating the fuzzy Front End of new product development. *Sloan Management Review* 1997;38(3828).
- [13] Smith PG, Reinertsen DG. *Developing products in half the time*. New York: Van Nostrand Reinhold Book, 1991.
- [14] Deschamps J, Nayak PR. *Product juggernauts: how companies mobilize to generate a stream of market winners*. Boston: Arthur D' Little Inc. Harvard Business School Press, 1995.
- [15] Slack N, Chambers S, Harland C, Harrison A, Johnston R. *Operations management*. Singapore: Pitman Publishing, 1995.
- [16] Rochford L. Generating and screening new product ideas. *Industrial Marketing Management* 1991;20:287–96.
- [17] Ulrich KT, Eppinger SD. *Product design and development*. Singapore: McGraw-Hill Inc, 1995.
- [18] Burchill G, Fine CH. Time versus market orientation in product concept development: empirically-based theory generation. *Management Science* 1997;43(4).
- [19] Khurana A, Rosenthal SR. Towards holistic 'Front Ends' in new product development. *Journal of Product Innovation Management* 1998;15:57–74.
- [20] Yin RK. *Case study research — design and methods*. 2nd ed. California: Applied Social Research Methods Series, 1994.
- [21] Quinn JB, Mueller JA. Transferring research results to operations. *Harvard Business Review* 1963.