

DECLINING PRODUCTIVITY IN PRODUCT DEVELOPMENT: AN EXPLANATION OF “PIPELINE GRIDLOCK”

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Keywords: product development, portfolio management, resource management, innovation capabilities

1. Introduction

When a company pursues too many projects compared with the resources available, and thus have to spread the scarce resources too thinly over the product development portfolio, it may result in congestion in the development pipeline. The phenomenon, often referred to as “pipeline gridlock, has serious implications for the productivity in product development. Many negative consequences stems from this gap between resources needed and resources available for product development: time-to-market for new products increases, the portfolio profile gets blurred and unfocused, the businesswise hit rate decreases and, subsequently, the business results suffer.

The aim of this paper is to investigate the nature of the phenomenon pipeline gridlock in product development, i.e. it will focus upon the questions: What is the nature of pipeline congestion, and which circumstances may cause it? The author recognize that the existing explanations cover many important aspects. In the research presented in this paper it is assumed that these explanations for pipeline congestion can be enriched by adding a consistent mindset, which explicates a number of circumstances and their sequential linking in an overall pattern of inherent causality, which forms a explanation for the phenomenon pipeline gridlock. The proposed mindset is based on an assumption that pipeline congestion is caused due to an unrealistic perception of the product development functions' capabilities among the senior management within the company. The research shall be considered as a contribution to the clarification of terminology and knowledge within the research area portfolio management and product development.

Furthermore, it is assumed that the proposed mindset can support the management in industry (i.e. R&D managers, portfolio managers, product managers etc.) in understanding and dealing with the phenomenon congestion in the development pipeline. Thus the contribution shall be considered as a productive mindset for industry management professionals, which complements the conventional tool-oriented approach to portfolio management.

The method employed to answer the research questions is a combination of explorative interviews with industry professionals in Danish and US companies and a literature review. Based on these sources the understanding of the pipeline gridlock phenomenon is identified by analysing the circumstances that may cause it and the relations between these circumstances. Based on this understanding the research presents a mindset, which subsequently is presented to experienced industry professionals for verification by accept.

Initially, this paper contains an overview of the results of an empirical study in the Danish and US industry. Second, a study of literature is pursued in order to identify and analyze aspects that can reveal insights on the phenomenon pipeline gridlock and thus help provide answers to the research questions. Next, the paper proposes a mindset aimed at explaining the pipeline gridlock phenomenon,

which subsequently is presented to industry professionals for verification. Finally, a conclusion is presented in the last section.

2. Empirical study

The empirical study includes six Danish and American companies and manufacturers of mechatronic products ranging from one-of-a-kind production to mass production. It is based on face-to-face interviews on location with staff from senior management such as R&D director, R&D manager, and portfolio manager. Semi-structured explorative interviews were employed for the study. In advance of the interviews a set of questions and an interview schedule was prepared with the defined purpose of identifying facts, behaviour and attitudes concerning current portfolio management practices in the company. They were particularly asked to explain what they consider to be the most significant challenges related to portfolio management for product development. The essence of the interviewee's response has been captured by making notes during the interviews. Some of the central statements are described in the next quotations in italic:

“Two factors motivate our efforts on improving the pipeline planning approach. First, unsatisfactory business results due to increased competition and changes in the market plays a significant role. Second, we [the management] assume that it is possible to better exploit capabilities across organizational functions, products and technologies and thus realize synergies.”,
[Manager, Strategic Business Unit].

“An enabling factor in getting the R&D portfolio under control was the efforts of the company controller to identify the current and planned activity of all R&D personnel. It became obvious that the stage-gate approval process was not functioning as planned, as there were multiple examples of projects staffed prior to their engineering approval, one with as many as 210 people.”,
[Product development manager].

“Once at a portfolio meeting we were discussing whether we should develop a certain product or not. Suddenly the R&D manager explained that the R&D department already was testing a prototype they had. Nobody knew of this before – that project was never funded.”,
[Portfolio manager].

“The increased globalization has made it much more challenging to pursue business through product development, because everybody instantly knows who's doing what, where, and when. The consequences for business are immense if we don't hit the window of opportunity timely with the right product in the right quality. Consumers simply won't tolerate low quality products today”,
[VP Product Management].

“We do experience the resource issue as a daily problem.”, [Project manager].

“Many technologies never gets inserted in products, because Product Development doesn't know what technologies the Technology Development Team intend to deliver. The Technology Development Team doesn't want to commit themselves to a plan”,
[Director of technology].

“The product innovation strategy is not documented. It results from individual action.”,
[R&D manager].

“We are working to increase the role of the Engineering Department in approving R&D plans, to assure that the plan seems reasonable and that the risks have been identified. Before, projects could be initiated without a technical statement of work or an assessment of risks. Projects were funded based on the vision of the end product without necessarily having a credible plan. Thus, often a miracle was needed in order to realize the products.”

[R&D director].

"It is difficult to get commitment from the rest of the organization to supply the needed resources.", [Director, strategic product planning].

"We have too many projects, and lack an explicit prioritization of them - large projects are weighted like small projects and vice versa.", [Technical marketing manager].

Due to the small sample size, the survey cannot be regarded as representative for either the Danish or US industry in general. The survey indicates that the phenomenon pipeline gridlock, i.e. too many projects for the resources available, still forms a significant challenge for many companies in the industry. The findings indicate that;

- it seems to be difficult for management to obtain a realistic and holistic picture of the company's product development capabilities.

For example, several of the above mentioned quotations reveals that considerable amount of resources (extending far beyond "skunk work" activities) are tied up in activities that have not been officially approved and funded. This implies that a proportion (beyond the expectations of the senior management) of the companies resources and competencies are deployed and developed outside the knowledge and purview of senior management.

- Furthermore, considerations about feasibility and probability regarding the realization of the product development portfolio seems to be weak.

In some companies the author observe a tendency to perceive the product development function as a "black box" that can deliver whatever product the Sales or Business Development Department etc. may promise the customers. Similarly, situations exists where the engineering staff autonomously pursues "exciting" products based on new technology, where crucial considerations regarding e.g. distribution or target segments for the products are vague at best. The gap between available and needed capabilities in order to realize the development portfolio remains unarticulated, and in some cases, as stated by a R&D director, it seems that a miracle may be needed if the company are to deliver the intended products.

- Finally, the author observe that a strategy for product innovation was not developed and articulated in the majority of the companies.

All of the companies engaged in some kind of business strategy session during the business year. However, it was evident that the implications for product development (i.e. the concept of a product innovation strategy) wasn't explicit considered. As one R&D manager stated it:

"We do a little too much "business as usual". Thus it is easy to re-use "old" specs. It is much more difficult to make specs for brand new ideas."

It seems that the absence of a product innovation strategy are reflected in the development portfolio resulting in an ambiguous portfolio profile.

3. Explanations offered from literature

The purpose of this section is clarify what explanations the literature provides with regard to the posed research questions: What is the nature of pipeline gridlock, and which circumstances may cause it?

Wheelwright & Clark [1992] recognizes the situation where companies have far too many projects going at once and all too often seriously over-commit their development resources. Referring to their PreQuip case they write;

"They discovered that 30 projects were under way - far more than anticipated, and, they suspected, far more than the organisation could support. Further analysis revealed that the company had two to three times more development work than it was capable of completing over its three-year development planning horizon."

They propose an Aggregate Project Plan as one solution to this problem. It is based on the fundamental assumptions that companies doesn't have a realistic perception of their product development capabilities and also lack sufficient strategic guidance for project selection. Wheelwright & Clark writes;

"When questioned, project leaders admitted that the strategic objectives outlined in the annual business plan had little bearing on project selection."

As a consequence the company's set of projects is inconsistent with the company's development strategies. According to Wheelwright & Clark this means that the development portfolio does not reflect and reinforce (i.e. facilitate and create synergy effects) the company's business strategy, which also might jeopardized the long term capability development. Declining productivity is another characteristic which Wheelwright & Clark also closely associate with pipeline gridlock. Referring to their PreQuip case they write;

"For some months, the development budget had been rising even as the number of completed projects declined", and also, "The more projects they added, the more their productivity dropped".

Paradoxically, the potential business value of the development portfolio did not reflect the increase in costs or projects, as they write;

"Many of the projects in the development pipeline no longer seemed to reflect the needs of the market."

These statements implies the dynamic and reinforcing nature of the problem. [Andreasen *et al* 1989] explains the declining productivity in the development function with the concept of debt. Debt consists of tasks and activities which either are remote to the development functions core tasks or caused by work that previously has been done insufficiently (i.e. poor execution of the work). Typically, the debt is continuously growing as a result of an inexpedient working pattern in the development function. Andreasen *et al* argues that debt arises from three main sources: *An enormous project and product portfolio*, which tend to be more and more unfocused combined with a misallocation of resources among the projects; *noise generation* is the result if an incomplete development task is transferred from development to the production, procurement, sales, service etc. Noise generation leads to new jobs, numerous tasks, timeconsuming problem fixing, changes, and firefighting etc. resulting in increased costs; *volume "sickness"* arises when the product development function is unable to determine when to release what product, and which features to include. Due to this unsteady sense for business creation many product variants are introduced causing a random growth in the product portfolio. Repenning [2001] recognise the existence of *fire fighting*, i.e. the unplanned allocation of resources to fix problems late in a product's development cycle, as a main reason for many companies do not reap the benefits from their product development process. He suggests that this "fire fighting" can be a self-reinforcing phenomenon that leads to a downward spiral, as he writes;

"Once it starts in one project, it is likely to spread to others, permanently degrading the capability of the development system".

He argues that the problem multiplies when the development system is multistage and multiproject oriented, which, indeed, is the situation for many companies today. Such systems are far more susceptible to fire fighting than is currently appreciated. Cooper & Edgett [2003] suggest that the problem is rooted in a significant shortage of resources devoted to product development. They refer to a major benchmarking study (for the American Productivity and Quality Center), where a lack of focus and inadequate resources surfaced as the number one weakness in businesses' new product development efforts. A lack of resources devoted to product development across all functions was the

number three most serious deficiency. According to Cooper & Edgett the shortage of product development resources causes several problems, which ultimately results in low profitability in product development. They specify three main causes for the resource crunch. 1) Short term profitability is considered as a fundamental cause. They write;

"To meet short term financial goals, business unit management was caught in a dilemma: They could do what was good for the business for the longer term, or resort to short term maneuvers - cost cuts and resource freezes - in order to achieve the immediate goals set by corporate headquarters."

In order to compensate for this situation technical persons are spread across too many projects. 2) Attempting to do too many projects and a lack of focus for the limited resources available is identified as another reason for the resource crunch. Cooper & Edgett writes;

"Indeed, the term "pipeline gridlock" was used by some managers to describe the situation in their business".

3) Overemphasis on speed to market is suggested as the final reason. In order to realize fast profits companies strive to reduce cycle time. This multiplies the problem, as they write;

"As time to market are compressed the rate of projects entering the pipeline increases".

Blichfeldt & Eskerod [2005] assume the gap between the needed and available resources for product development is due to the existence of smaller projects that are not being enacted by the senior management. This set of unauthorized projects drain resources from the projects that the resources, initially, were dedicated to. They suggest that at an aggregate level the "un-enacted" projects qualifies as "resources crunches" in so far these projects are not considered a part of the enacted portfolio. The findings of Blichfeldt & Eskerod implies that the senior management in companies are lacking the necessary leadership or control to ensure that their decisions gets implemented as planned. Additionally, a fact-based understanding of the organisation's development capabilities seems to be missing. Patterson [2005] recognizes the dilemma regarding control and creativity: on the one hand a key part of the portfolio management responsibility is to ensure that the R&D investment is being spent as intended. On the other hand, new projects often begin by "spontaneous combustion" in many firms, outside the purview of higher level managers, and thus not as enacted projects. He argues;

"A certain freedom for experimentation is desirable and can lead to important learning, even breakthroughs."

Patterson proposes that this activity should not be accepted as clandestine behavior. Instead, it should be a conscious part of the R&D investment portfolio. Harris & McKay [1996] suggests that the absence of a fact-based understanding of the organisation's development capabilities encourage the formulation of unrealistic product development strategies. Furthermore, they consider the planning approach applied in many companies as inadequate for a high-performance product development process. The problem is that projects and functions are viewed discretely, not in aggregate. Hence cross-project management on a continuously basis is omitted. They write;

"Usually, the connection between strategy, project management, and functional management is limited to the annual budgeting process - a holdover from the functional orientation of the past ...".

Harris & McKay argue that this situation results in development output which is far from being maximized, connections between strategic plans and actual deployment of resources are nebulous, and the organisation lacks the flexibility to respond rapidly to changes.

3.1 Overview of explanations for pipeline gridlock

The empirical study and the study of the literature has shown that many circumstances (Table 1) contribute to realize the phenomenon pipeline gridlock. These circumstances seems to be interrelated in a complex pattern, that are dynamic, iterative and negatively reinforcing. The outcome is a product development context characterized by opacity, lack of cross-project and cross-functional coordination and integration, strategic misalignment of resources, low degree of synergy between activities, reduced flexibility to respond rapid to changes, and an endangered capability development which, ultimately, mounting into a fragile development system with declining internal and external productivity.

Table 1. Classification of circumstances which may cause pipeline gridlock identified in literature and industrial practice

Circumstances which may cause pipeline gridlock	Author / Source							
	Wheelwright <i>et al</i>	Andreasen <i>et al</i>	Cooper & Edgett	Blichfeldt <i>et al</i>	Patterson	Harris & McKay	Repenning	Empirical study
Unrealistic perception of the R&D functions' capabilities	X		X	X		X		X
Unauthorized projects exists that drains resources from other projects	X			X	X			X
Nebulous connections betw. strategy and actual resource deployment	X	X	X			X		X
Projects /functions are viewed discretely, not in aggregate	X					X		
Too many projects in the pipeline	X	X	X					
Resources spread too thinly on many projects	X	X	X					
Poor execution of projects and tasks	X	X	X					
Shortage of resources devoted to product development			X					
Preoccupation with short term profitability			X					
Overemphasis on time-to-market			X					
Unsteady sense for business creation		X	X					
"Noise" generation, i.e.quality issues, problem fixing etc.	X	X	X				X	

The list of identified circumstances are essential, but not necessarily complete.

4. An explanation of pipeline gridlock

The empirical study industrial survey and the literature study has identified several circumstances and their relations which characterize and explains the pipeline gridlock phenomenon. The aim of this research is to derive and contribute with a productive mindset which can support industry professionals in their efforts with composing a businesswise strong product development portfolio which is aligned with the precious resources available. The mindset is founded upon the aggregated knowledge above, which is embedded in an explicit framework (Figure 1) articulating an overall pattern of inherent causality, which the author assume forms a plausible explanation for the phenomenon pipeline gridlock. Eight of the identified circumstances (Table 1) are assumed central for the explanation and thus integrated in the proposed framework. The remaining circumstances are assumed to be of secondary importance.

In order to understand the mindset it is important to explain each of the embedded circumstances and the causality between them. A central finding from the empirical study and the literature study implies that a substantial proportion of the companies resources and competencies are deployed and developed outside the purview of senior management. This situation forms an impediment for obtaining a realistic and holistic picture of the company's product development capabilities. The mindset proposed in this research rests upon the fundamental assumption that pipeline gridlock is caused due

to an unrealistic perception of the product development functions' capabilities within the senior management group (circumstance A). It follows that it is difficult to define and articulate a product innovation strategy, which is considered crucial to provide guidance and criteria for selection of projects to the product development portfolio in accordance with Cooper [1984], Baker & Hart [1999], and Crawford & Benedetto [2003]. The lack of explicit criteria complicates project selection and prioritization, and makes it difficult to decline a proposed project or stop a project already underway (B). This leads to a proliferation of projects in the development portfolio (C). In an attempt to try to support the plethora of projects engaged, each member of the product development staff are assigned to contribute to several projects in parallel. The outcome (D) is that the resources are spread too thinly on too many projects.

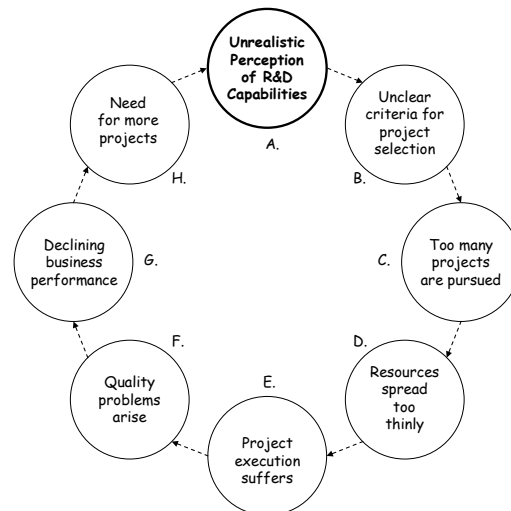


Figure 1. An explanation on pipeline gridlock: The proposed thinking pattern consists of a set of defined and interrelated circumstances which are embedded and linked in a cyclical pattern in order to explicate the negatively self-reinforcing and dynamic nature of the phenomenon. It rests upon the fundamental assumption that pipeline gridlock is caused due to an unrealistic perception of the product development functions' capabilities within the senior management group in the company

In order to make ends meet the engineers are constantly reassigned between the various projects, and the reshuffling comprises a strain on the resources which causes delays in other projects and the internal productivity decreases due to a rise in development costs. Project managers are confronted with pressure to cut corners and compromise quality just to keep their projects moving forward, and subsequently, execution quality starts to suffer (E). This compromise in the quality of project execution will inevitably be reflected in the business the products are intended to create. First, development delays effects the timing for the introduction of the products to the market, and the "window of opportunity" may be missed. Second, the products lack competitive advantage due to missing features etc. Third, after market introduction the customers will begin to experience quality problems with the products (F). This entails that the engineers have to spend considerable time responding to requests from manufacturing, quality assurance and field sales for help with customer problems, - all adding to the cost of the projects, and contributing to degrading the internal productivity. As a reaction to the obvious quality problems with the products, the customers gradually will switch to purchase the competitors' products, and eventually, the revenue from products will decline. (i.e. decreasing the external productivity). The combination of a rise in costs and failing revenue is obviously hazardous for the profits of any company, and will ultimately result in declining business performance (G).

The notion of the declining business performance will eventually become evident for the company's senior management, who are obliged to react to the situation. The senior management faces pressure

to realize short term profitability, and in an attempt to satisfy stakeholders they tend to resort to a combination of rationalization (cost cuts) and demanding more projects from their subordinates that can realize new and "innovative" products, which can contribute to improve the revenue stream (H). The latter circumstance closes the cyclical pattern, and its dynamic nature brings us back to the initial circumstance - namely the fundamental assumption that pipeline gridlock is rooted in an unrealistic perception of the product development functions' capabilities (A). Hence the process repeats itself in a negatively reinforcing iteration and a "viscious circle" is created.

This mindset is to be perceived as an enrichment of the existing explanations for pipeline gridlock. Even though it is beyond the purpose of this mindset to propose a solution to the problem, the mindset implies a path for the solution; namely the establishment of a realistic perception of the company's R&D capabilities. In industrial practice the mindset is supposed to be complemented with the deployment of various concepts, methods and tools aiming at providing solutions at strategic level, portfolio management level and tactical level in accordance with Cooper & Edgett [2003].

In order to validate the proposed explanation it has been presented to managers in three Danish companies. Some of their reactions from the confrontation are captured in the following statements:

"When a crisis exist or ambitious goals are pursued you typically chase many ideas simultaneously. This encourages lack of focus, widespread allocation of resources and unclear prioritization. Delays, "wrong" products or even worse, no products, may be the consequence. This mechanism is unmistakably captured in the vicious circle". [R&D Director].

"The core in achieving businesswise success for a company on the global market is to ensure that a steady stream of innovative, high quality products with a distinct, competitive edge are introduced to the market at the exactly right time. From my 10 years of experience within product management I clearly recognize the elements and the pattern described in the model as a challenge for the realization of business goals. It is important that companies are aware of the phenomenon, so they can avoid being caught up in the destructive pattern. I see interesting perspectives in the dissemination of the model.", [VP, Product Management].

Every company wants to be innovative. But when is a product innovative enough? This is a central question we often are confronted with, and it is a dangerous cocktail when mixed with creative engineers and sales people. The answer to the question requires a deep understanding of the boundaries, i.e. the company's development capabilities and the market conditions. Otherwise you can continue to hunt ideas forever. The worst part is that the problem intensifies as your portfolio grows with new product lines and line extensions. This paradox is crystalized in the mindset, which I think makes perfectly good sense.", [R&D Project Manager].

Bearing in mind the limited scope of the industrial validation, it seems that the proposed mindset is acceptable to industry professionals.

4. Conclusion

"Pipeline gridlock" in product development is a phenomenon which has serious implications for the productivity in product development. Even though many explanations and solutions have been offered in the literature, it still seems to pose a major challenge for companies in the industry.

Based on an assumption that pipeline gridlock is caused due to an unrealistic perception of the product development functions' capabilities within the company, this research proposes a holistic mindset for understanding pipeline gridlock. The mindset consists of a set of defined and interrelated circumstances which are embedded and linked in a cyclical pattern in order to capture and explicate the self-reinforcing and dynamic nature of the phenomenon.

Industry professionals have been confronted with the mindset, and their positive reactions gives reason to believe that the mindset will be an important step towards unlocking the pipeline gridlock that many companies struggle with on a daily basis across organizational levels and functions. The author

believe that this step is fundamental and imperative in order to compose and continuously maintain a strong and healthy product development portfolio.

Acknowledgements

The author would like to thank the industry professionals who have contributed to the research reported in this paper. Additionally, the author would like to thank Mogens Myrup Andreasen, Niels Henrik Mortensen and Saema Ahmed, Technical University of Denmark, for providing valuable comments to the work.

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