

# The process of selecting technology development projects : a practical framework

**Citation for published version (APA):**

Herps, J. M. J., Mal, van, H. H., Halman, J. I. M., Martens, J. H. M., & Borsboom, R. H. M. (2003). The process of selecting technology development projects : a practical framework. *Management Research News*, 26(8), 1-15. <https://doi.org/10.1108/01409170310783619>

**DOI:**

[10.1108/01409170310783619](https://doi.org/10.1108/01409170310783619)

**Document status and date:**

Published: 01/01/2003

**Document Version:**

Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

**Please check the document version of this publication:**

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

**General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

[www.tue.nl/taverne](http://www.tue.nl/taverne)

**Take down policy**

If you believe that this document breaches copyright please contact us at:

[openaccess@tue.nl](mailto:openaccess@tue.nl)

providing details and we will investigate your claim.

---

# The Process of Selecting Technology Development Projects: A Practical Framework

by *Joost M.J. Herps, Herman H. van Mal, Johannes I.M. Halman*, Eindhoven University of Technology, Eindhoven, The Netherlands; *Jack H.M. Martens, Ron H.M. Borsboom* (DAF Trucks Company, Eindhoven, The Netherlands)

## Abstract

In this article a practical framework is proposed, that can be used to organise the activities related to the selection-process of technology development projects. The framework is based upon recent literature and application at DAF Trucks Company. A technology development project has a long way to go, before it contributes to the productivity of the company. This long lead-time causes uncertainties and risks. Changes in market-preferences and upcoming alternative technologies can prematurely make the developing technology become obsolete. In order to reduce the uncertainties and risks, the main technology opportunities and threats need to be identified as early as possible and submitted to a validation process. The technology opportunities and threats then have to be moulded into well-defined project-propositions. Out of the project-propositions those projects should be selected that will best meet the long-term objectives of the company. This paper is intended to be used as a reference for companies who want to improve their technology development selection process.

## Introduction

Technology development is strategically important according to Porter [in Burgelman, 1]. The power of technology as a competitive variable lies in its ability to alter competition through changing industry structure. To achieve its technology goals, the company only has a limited number of resources at its disposal. Both the strategic importance and the scarce resources underline the importance of making a good selection out of the available possibilities. A good selection requires a well-organised selection-process. In the opinion of the authors, at least three conditions need to be fulfilled regarding the organisation of the selection-process:

1. The company's long-term objectives regarding the product-assortment need to be determined and communicated towards all those concerned in the technology selection-process. The priorities of the selection should be derived from the long-term objectives. Ignoring this condition might lead to an incoherent technology portfolio to be selected.

The process of  
selecting  
technology  
development  
projects

2. The technology opportunities and threats need to be identified periodically and systematically. Important is that the identification is made in time. Often, the market-introduction dates of new product (types) are determined years before. An early identification gives the company extra time for the development of a new technology that can be implemented in the new product (type) through an altered product-function.
3. The selection as well as the execution of the technology development projects needs to be carried out in a purposive way. From the start all efforts should be taken in order to fit the project's result into a new product or value-chain. Ignoring this condition will almost definitely lead to the project fading away before a contribution to the company's productivity has been made.

The main question of this article is, in what way a company can organise the activities of the technology selection-process in order to fulfil the 3 conditions. To answer this question relevant literature first will be discussed, a theoretical framework will be derived and a practical framework, based on a Stage Gate model, will then be developed. In a following section we will describe the organisational functions that are required to make the practical framework work in practice. Both the practical framework as well as the organizational functions have been developed to be applied within the organizational setting of a Truck company. Finally the paper will discuss the applicability of the proposed framework.

### **A theoretical framework**

The objective of this article is to develop a practical framework, which can be used as an instrument to organise the activities of the selection-process of technology development projects. To begin, a theoretical framework will be derived from relevant literature. This theoretical framework, which in a following step will be moulded into a practical form, will be based upon frameworks of Narayanan [2] and Nagel [3] for developing a *Technology-Strategy*. Also Cooper's framework [4] for portfolio management will be used.

According to Narayanan [2], 4 stages need to be carried out in order to come to a technology portfolio that fits the long-term objectives of the company. The first Stage, *Strategic Diagnosis*, is aimed at assessing both the Technological as the Business environment of the company. To do so, Narayanan identifies the actual and potential technologies inside and outside the firm, assesses the applications that might merge from them, and determines the impact of these applications on current and future competitive domains (*environmental assessment*). Then Narayanan assesses the firm's technology strengths in comparison with its competitors and the technology requirements that can be derived from its strategic position in the market. In the second stage of Narayanan, *Formulation of Technology Strategy*, the

---

company decides to commit resources to a select set of technology choices. During the third stage, *crafting an implementation approach*, preparations are being made for the implementation of the technology choices. The final stage, *Execution*, focuses on executing the chosen projects.

Nagel [3] also explains how a company can select a technology portfolio that fits its long-term objectives. His framework contains 7 steps. The first step, *assessment of current technology strengths and weaknesses*, analyses the technological potential of the company. The second step, *assessment of externally available technologies*, involves scanning and screening of the technology environment. The third step is about generating strategic alternatives (*generation of strategic alternatives*). The fourth step, *Decision Making*, focuses on determining the future technology direction of the company. *Action planning and preparation of implementation*, is Nagel's fifth step. The sixth and seventh step, *Implementation and Evaluation*, focus on the execution of the technology development projects and the periodic evaluation of the results.

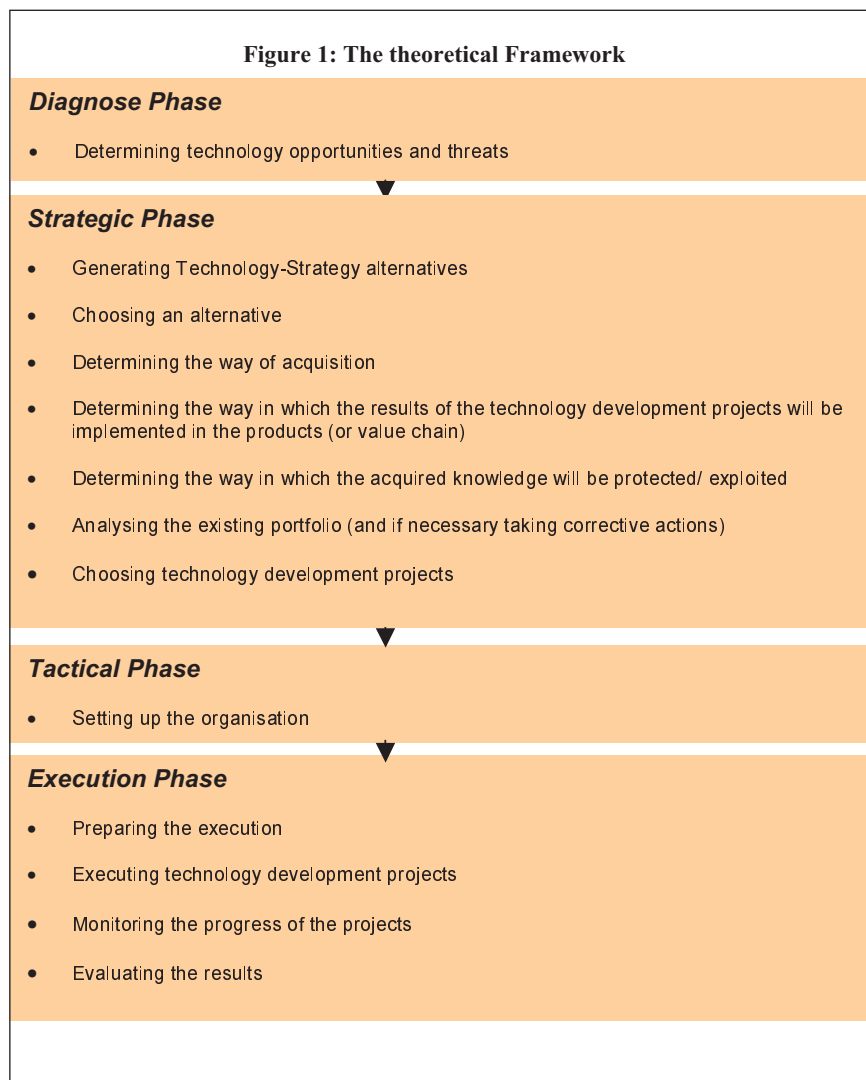
Selecting technology development projects is a recurrent process. This means a technology portfolio already exists at the moment a selection takes place. Cutting back on disappointing projects can create opportunities for new technology development projects. Therefore, the existing portfolio needs to be submitted to a reselection. Cooper [4] explains in 8 steps how an existing portfolio can be adapted to a new situation. The first step focuses on determining the long-term objectives of the company. During the second step the company's Key Strategic Dimensions (KSD) are chosen. Resources can be allocated to these dimensions. According to Cooper, important dimensions are: *Strategic goals, Product lines, Market segments, Technology types, Project types, etc.* The third step is about dividing the KSD into *Strategic Buckets* (areas of value). Later on these buckets can be filled with resources. The fourth step is about categorising the existing projects over the strategic buckets and determining the current spending in each bucket. The fifth step focuses on determining the desired spending in each bucket. In the sixth step a comparison will be made between the current and desired spending in each strategic bucket. Differences between the two levels are identified as gaps. The seventh step is about ranking current projects in the strategic buckets. If under- or overspending occurs, measures can be taken to close the gap (eighth step).

Now, a theoretical framework will be derived from the discussed literature. The theories of Narayanan, Nagel and Cooper will be brought together in the framework. The theoretical framework will be based upon three decision levels as indicated by Van Mal [5]. According to Van Mal among every company's activities 3 decision levels can be distinguished: the strategic level, the tactical level and the executive level. On the strategic level decisions are taken regarding the future product portfolio and the potential technology development projects. At the same time will be determined in which

**The process of  
selecting  
technology  
development  
projects**

**The process of selecting technology development projects**

way the technological knowledge can be accessed (internally or externally). This also includes patents. The strategic decisions are made using the criteria of the best contribution to the (long term) productivity of the company. On the tactical level decisions are taken regarding the organisation of the technology development projects (any overlapping knowledge areas or shared activities?). This involves project's activities and an implementation in a project organisation. This structuring process opts for the best performance of quality, time and costs of projects and project execution. On an executive level decisions are made regarding the allocation of capacities and facilities. Furthermore, a systemisation of working methods will be established to obtain the most productive use of capacities (all available sources). The theoretical framework is shown in figure 1.



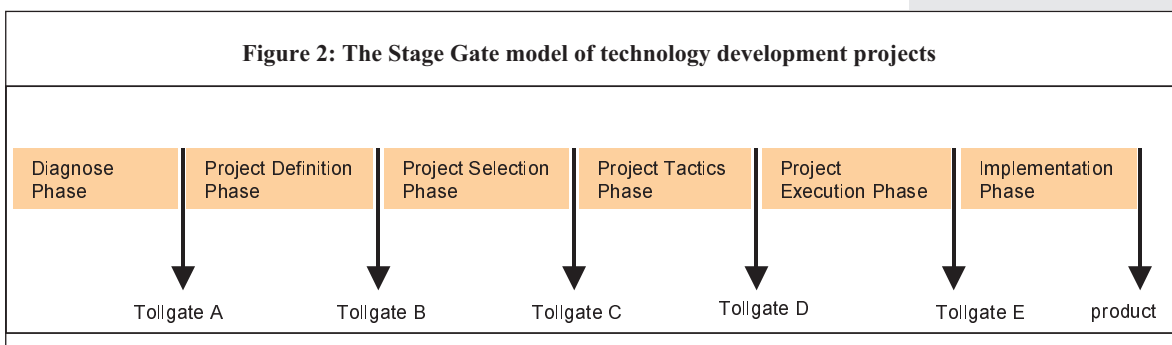
## The Stage Gate Model for Technology Development Projects

The theoretical framework model from figure 1 will now be moulded into a practical form. In this case the practical form will be a Stage Gate model. Cooper [7] explains that a Stage Gate model splits up the product innovation process into several Stages. Each Stage consists of prescribed, multifunctional and parallel activities. A Gate gives the access to a Stage. Cooper states that the Gates control the quality of the process, functioning as Go/Kill checkpoints. A Stage Gate model supports processes that are characterised by uncertainty and pressure on obtaining a reduction in lead-time and at the same time improving the quality (Cooper [7]). The quality of a technology development project can be defined as the extent to which the result is useful (and reliable) for application in means of production or in a new production process. Aimed at more productive realisation of (new) product function(s).

In figure 1 four Phases have been described: *the Diagnose Phase, the Strategic Phase, the Tactical Phase* and the *Execution Phase*. The eventual Stage Gate model of technology development projects is given in figure 2. The Diagnose Phase of the theoretical model corresponds with the first Phase of the Stage Gate model (*Diagnose Phase*). The activities of the Strategic Phase have been transferred into the *Project Definition Phase* and the *Project Selection Phase*. The Tactical Phase corresponds with the *Project Tactics Phase*. The same goes for the Execution Phase and the *Project Execution Phase*. Finally the Stage Gate model contains an extra Phase, the *Implementation Phase*, in which the technology development projects are being integrated in the product development projects. According to the theoretical model, evaluations regarding the results of technology development projects need to be held during the Execution Phase. In the *Project Execution Phase* of the Stage Gate model the project's results are therefore evaluated at tollgate E.

Supplementary to the theoretical model, evaluations in the Stage Gate model will also be held during the selection (on tollgates A, B, C and D). These additional evaluations are important for a good selection and keeps management sharp.

The process of selecting technology development projects



Before the Stages of the Stage Gate model are elaborated on, the main functions will first be described.

### A Description of the Main Functions

In order to carry out the activities of the Stage Gate model, a number of functions need to be described. The descriptions of these functions are partly derived from literature, complemented with practical experiences at DAF Trucks Company. Five important functions will now be discussed.

*Chief Technology Officer (CTO):* The responsibility of the technology development process is assigned according to Roussel [8] to the “*Chief Technology Officer (CTO)*”. Dickerson [9] states that the CTO’s main task is to maintain the technology infrastructure of the company and to support strategic decisions of the management. Also in this Stage Gate model, the responsibility is assigned to the CTO. He informs the management of the company about the consequences of choosing a technology strategy and links the Technology to the Business.

*Technology Secretary:* The description of the “*Technology Secretary*” stems from practical experiences during the implementation of the Stage Gate model of technology development projects. The position of the CTO makes him a very occupied person. This restrains him from executing the role of organiser in the technology development process. This role will therefore be assigned to the “*Technology Secretary*”. He makes sure that the activities are carried out on time (ringing bells), that meetings are arranged and that important information is stored systematically and instantly is available.

*Technical Committee:* During the selection, important decisions are taken based upon technical information. In order to increase the reliability of this information, a Technical Committee is created. The Committee carries out technical evaluations and monitors the progression of the technology development projects. The Committee consists of people who are well known for their excellent technical-scientific knowledge of the product.

*Business Committee:* The CTO has to make sure that the selected technology development projects fit the company’s business. The Business Committee is created to support him in achieving this objective. The members of the Committee all represent one of the value areas of the company. Cooper [4] calls these areas of value “*Strategic Buckets*” and from now on this expression will also be used in this article. Three possible *Strategic Buckets* are: *the customer, the government and the company*. The members of the Committee inform the CTO about the urgency, regarding their own *Strategic Bucket*, in which certain technology development projects need to be carried out. It’s recommendable to install members originating from outside the product development department. A wide spread allocation of the Committees members throughout the company will likely increase the compa-

ny's support for technology development projects. Later on, this support comes in handy when the results of the technology development projects need to be adopted by the rest of the company.

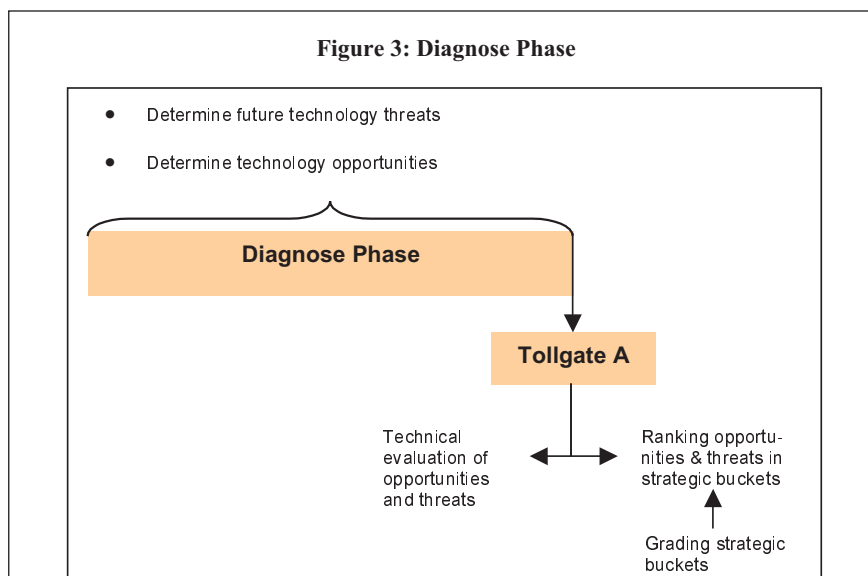
*Product-property owners:* Technological knowledge can be defined as the knowledge of regularities regarding materials and processes. Thanks to technological knowledge changes in physical behaviour (product-properties) can be explained and predicted, in order to establish an intended product-function (Van Mal [6]). The expression product-property links technological knowledge to functionality. Therefore, to each relevant property (for example: reliability, weight, manoeuvrability, user's safety and space-occupation) a specialist is made responsible: the product-property owner. Not only does the owner represent his property's interests in the technology development process, but also in the other related company's processes. In order to protect the charisma of the job, it is sensible to restrict the number of product-property owners.

The different Stages of the Stage Gate model will now be explained.

### Diagnose Phase

During the Diagnose Phase (figure 3) an inventory will be made of all the important technology opportunities and threats. The product-property owners will control this process.

At tollgate A two evaluations take place. The first evaluation has a technical character. A technology opportunity or threat might possibly lead to changes in the product-functions of future products. The product-property owners will assess the impact of these changes for their own properties. Dur-



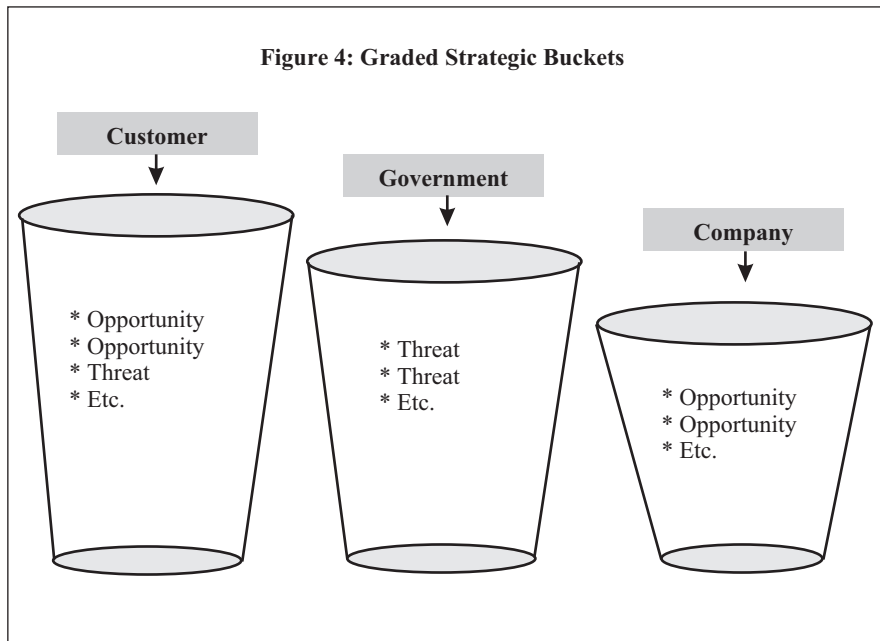


**The process of selecting technology development projects**

ing the technical evaluation the Technical Committee will verify the assessments.

The second evaluation at tollgate A is aimed at assessing the most important opportunities and threats. The Business Committee will rank the technology opportunities and threats in the company's strategic buckets. In the example of the three strategic buckets (the *customer*, the *government* and the *company*) three priority lists are created filled with opportunities and threats (figure 4). Meanwhile, the company's management has been asked to grade each strategic bucket, in order to point out the future technology direction of the company. This step relates to a certain extent to the literature described, since the company's management is given the opportunity to select from several strategic alternatives.

The Diagnose Phase approach has 3 positive effects:

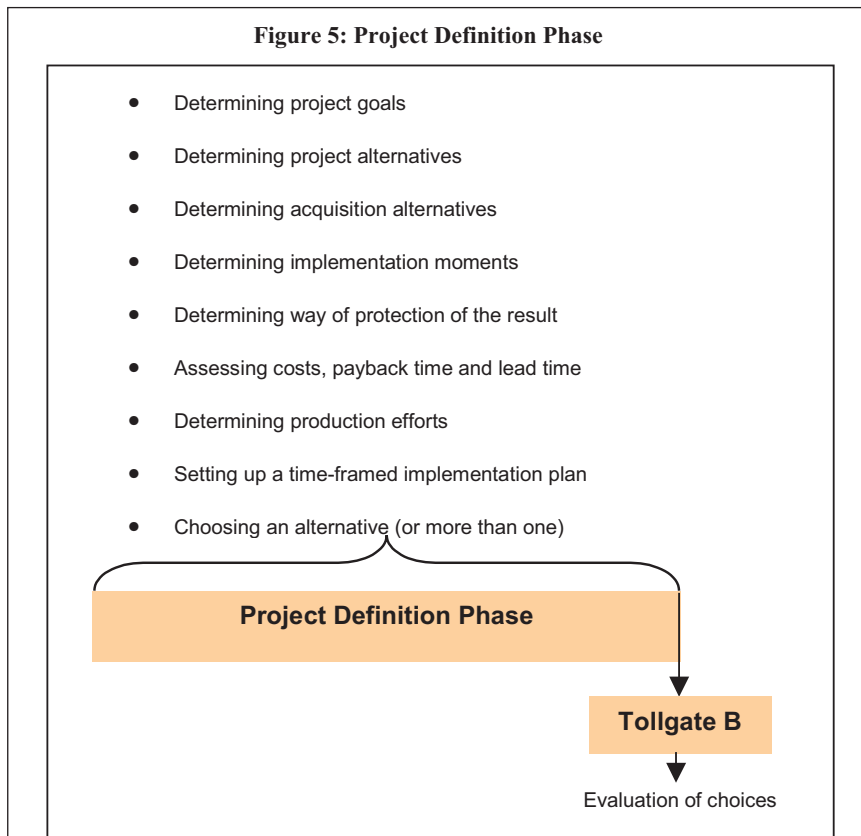


- The structured approach makes sure that the technology opportunities and threats are identified rapidly. Consequently, the company will have more time at its disposal to anticipate the opportunities and threats.
- Opportunities and threats that do not pass tollgate A, do not require a project proposition to be made. Therefore, it is prevented that the company wastes money on projects that do not have the potential to add value to the company.

The business evaluation makes it easier to set clear and measurable project goals for the project propositions that can be derived from the opportunities and threats.

### Project Definition Phase

In this Phase project propositions will be derived from the technology opportunities and threats (figure 5).



The first activity of the *Project Definition Phase* is the determination of the project goals of the technology development projects. This activity is relatively easy, since the objectives can be derived directly from the estimated contribution to the added value at tollgate A. The second activity is the assessment by the property-owners of the project alternatives. For each alternative acquisition-ways are determined. After this, for each acquisition-way the implementation moments of the result are determined. This concerns the determination of the right moment to integrate the results of the technology development projects into the product development projects. Also is determined how the project's result can be protected from the outside world.

**The process of  
selecting  
technology  
development  
projects**

After this, estimation is made of the costs, the payback and lead-time of the possible acquisition-ways. Also we look at the effect that each alternative will have on the production process. For each acquisition-way a time-framed implementation plan will be set up. This plan describes how an eventual implementation will be achieved. Finally, for each project proposition one or more alternatives (and matching acquisition-ways) will be selected. On tollgate B an evaluation takes place regarding the selected alternatives. During this evaluation, the Technical Committee will determine whether the right alternative has been chosen.

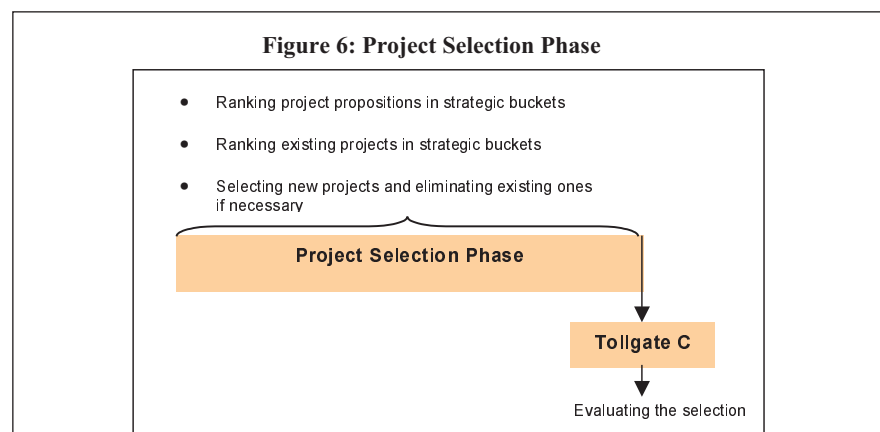
The Project Definition Phase approach has 2 positive effects:

- By setting up an implementation plan the chances of an implementation of the developing technology increase.
- The approach offers the possibility to anticipate risks. These risks can be reduced by choosing various alternatives for each opportunity or threat.

### **Project Selection Phase (figure 6)**

Now that the project costs have been estimated, the expected productivity can be determined for each project proposition using the formula “productivity = added value/ costs”. The project propositions in the strategic buckets will be ranked according to their contribution to the company’s productivity.

The projects of the existing technology portfolio can also be ranked in the strategic buckets according to their expected productivity-contribution. Using both the updated priority lists and the guidance of the management, it can now easily be determined which new technology development projects will have to be selected and which existing ones will have to be eliminated. On tollgate C the selection will be evaluated. During this evaluation the new technology portfolio will be presented and explained to the company’s management.

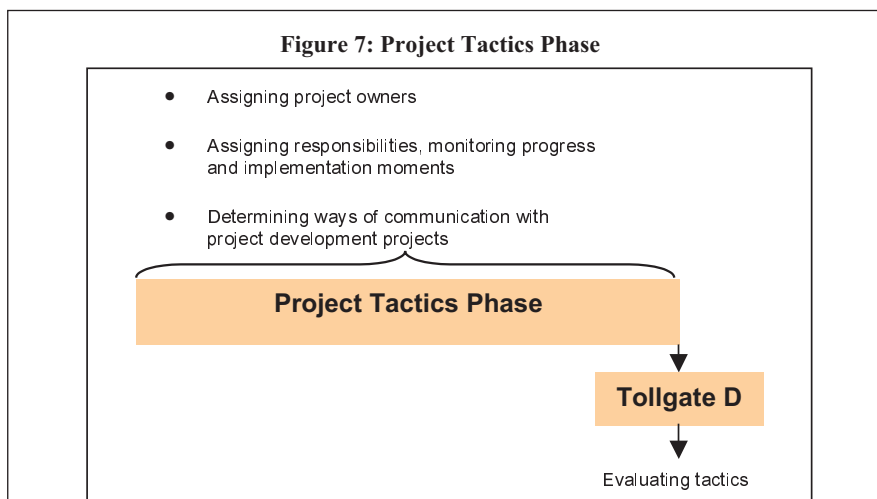


The Project Selection Phase approach has 2 positive effects:

- The selectors will have a clear picture of the possible technology development projects at the moment the selection takes place.
- The evaluation of the selected technology portfolio keeps the management involved in the technology development process.

### **Project Tactics Phase**

In this Phase project owners will be assigned to the selected technology development projects (see figure 7). Furthermore, responsibilities are assigned for monitoring the projects' progress and the implementation moments. Finally, the ways of communication between the project owner and all involved in the project development projects are determined and at Tollgate D the results of the Tactics Phase are evaluated.



The Project Tactics Phase approach has 2 positive effects:

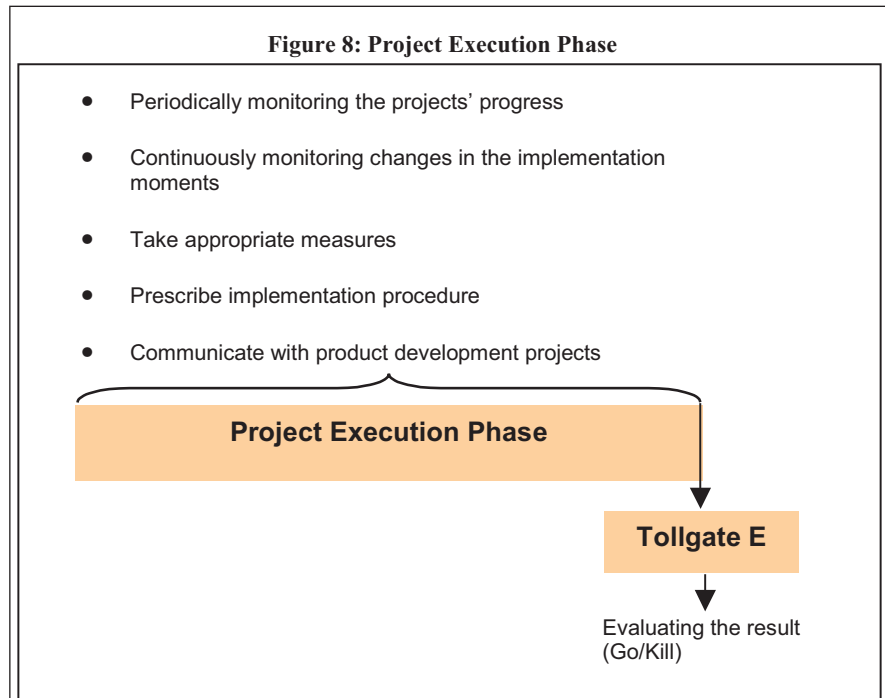
- The responsibilities regarding the execution and the implementation of the technology development projects are being assigned.
- Determining the ways of communication between the technology and the product development projects improves the quality relations between the projects.

### **Project Execution Phase**

In the Project Execution Phase (figure 8) the technology development projects and the implementation moments are monitored. If changes occur in the implementation plan, appropriate measures will be taken. At the end of the Project Execution Phase an implementation procedure is being set up and communicated to the responsible co-workers in the technology develop-

## The process of selecting technology development projects

ment projects. At tollgate E the project's results are evaluated. During this evaluation the company's management-board is present and the decision is taken whether or not to implement the developed technology in the product development projects.



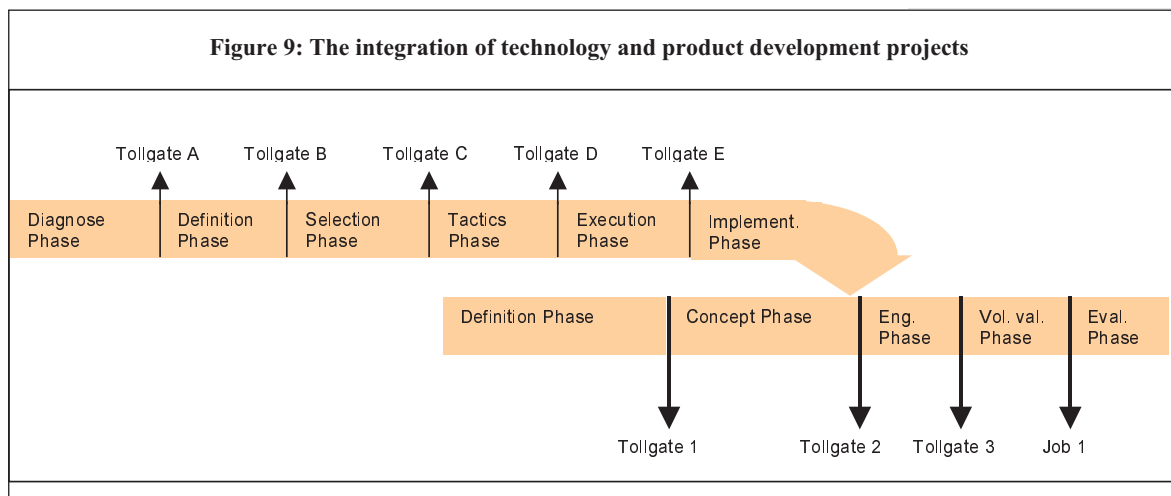
The Project Execution Phase approach has 2 positive effects:

- The approach enables the company to take appropriate actions early when changes in implementation moments or project-progress are manifest. Unnecessary costs can thus be avoided.
- The evaluation with the company's management board increases the chances of implementation of the developed technologies. Furthermore, the evaluation will have a positive effect on the company's potential for future technology development projects, as well as the future budget for technology development.

### Implementation Phase

After an implementation has been improved, the developed technology will have to be integrated into product development projects. Given its strategic impact we recommend to evaluate the technological, organizational and commercial feasibility by applying the Risk Diagnosing Methodology (Halman [11]). In case the organisation of these projects is also based upon a Stage Gate model, the integration will be similar to the one in figure 9.

**Figure 9: The integration of technology and product development projects**



During the Implementation Phase, carefully chosen activities enable the technology development projects to flow into the product development projects. Since the implementation method depends strongly on the organisation type and its product development process, this article will not further elaborate on the activities of the Implementation Phase.

### Conclusion and Remark

The practical framework has been developed to organise the activities of the selection-process of technology development projects in order to save time and money and to sustain effective product innovation.

The framework based on the Stage Gate model enables the company to identify its technology opportunities and threats structurally and in an early phase. A link has been established between the company goals and the selected technology portfolio. The entire technology development selection process is aimed at increasing the chances of implementation of new technologies. The proposed practical framework for the selection process of technology projects was developed in cooperation with members of the DAF Truck Company in Eindhoven (Netherlands). To achieve their technology goals, the company only has a limited number of resources at its disposal. Both the strategic importance and the scarce resources underline the importance of making a good selection out of the available possibilities.

### Remark.

There still remains the question to be answered: “*to which companies will the framework serve as a usable instrument?*” The quality and timing of the technology projects are very important for the innovation process of a company. The proposed approach demands some extra company-efforts and a certain discipline. A company with only a modest budget for technology development at its disposal might fear to waste more resources on the organi-

**The process of  
selecting  
technology  
development  
projects**

---

**The process of  
selecting  
technology  
development  
projects**

sation of the practical selection activities than on the actual execution of technology development projects.

However, the authors are convinced that the approach can still be also suitable for smaller companies. The role of the Technology Secretary will be even more important for companies with smaller groups working on technology development projects. The management functions described in this paper could in that case be combined, in order to create an organisation that fits the company's size and the budget for technology development. The European *Industrial Research Management Association* [10] even recommends the members of the technology development projects to work part-time in the company's execution process. This will serve them to be more knowledgeable for the selection process of technology development projects. However, further application of the proposed approach in practice and systematic evaluation of its effects are required to provide enriched knowledge about its potential applicability within different contexts.

---

## References

- [1] R.A. Burgelman, M.A. Maidique [1988], "Strategic Management of Technology and Innovation", Richard D. Irwin Inc.
- [2] V.K. Narayanan [2001], "Managing Technology and Innovation for competitive advantage", New Jersey: Prentice Hall.
- [3] A.P. Nagel [1995], "A Framework for Technology-Strategy", In: M Bruce and W. G. Biemans (editors), *Product Development: Meeting the Challenge of the Design-Marketing Interface*, John Wiley & Sons Ltd.
- [4] R.G. Cooper, S.J. Edgett, E.J. Kleinschmidt [1998], "Portfolio management for new products", Massachusetts: Addison-Wesley.
- [5] H.H. van Mal [1997], "An hierarchical set of indicators in the production organisation to tune entrepreneurial activities", PICMET, Portland International Conference on Management, Engineering and Technology, Portland US (Available on CD-ROM PICMET'97)
- [6] H.H. van Mal, J.C.M. van den Molengraaf, R.H.A.M. van den Broek [2002], "Customer oriented scientific design: a "contradiction in terminis" or a winning combination?", *International Journal of Technology Management*, Vol. 24, Nos. 2/3, Interscience Enterprises Ltd.
- [7] R.G. Cooper [1993], "Winning at new products, accelerating the process from idea to launch", Perseus Books
- [8] P.A. Roussel, K.N. Saad, T.J. Erickson [1991], "Third Generation R&D", Boston: Harvard Business School Press.
- [9] C. Dickerson [Nov. 5, 2001], "Hitting the road", Framingham: InfoWorld.
- [10] European Industrial Research Management Association (EIRMA) [1998], "Technology Monitoring", Paris.
- [11] Keizer, J.A., Halman, J.I.M. and Song, M. [2002], "Applying the Risk Diagnosing Methodology RDM", *Journal of Product Innovation Management*, Vol 19, pp 213-232.

**The process of  
selecting  
technology  
development  
projects**