Innovation Management for Technical Products

Systematic and Integrated Product Development and Production Planning

Bearbeitet von
Walter Eversheim

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2 Integrated Innovation Management

WALTER EVERSHEIM, ELKE BAESSLER,
THOMAS BREUER

Innovation Management deals with a complex and multilayered field of activities whose successful processing requires a holistic and integrated approach.

- The Aachen Innovation Management Model AIM represents the reference framework for the innovation management. It enables identifying integration gaps and educing needs for action (Chap. 2.1).
- The Innovation Portfolio is used to adjust a "healthy" innovation project mix (Chap. 2.2).
- The Aachen Strategy Model for product innovation integrates the market pull and the technology push approach (Chap. 2.3).

Content complexity

The system-theoretical approach of the St. Gallen Management Concept SGMK allows the adoption of its general management approach to subsystems, i.e. enterprise units and enterprise tasks[1] (cf. Schuh and Schwenk 2001). The Aachen Innovation Model AIM was designed as a part concept of the SGMK and represents the reference framework for innovation management. Thus, logically delimitable scopes of duties can be accentuated, which are dealt with by the management (cf. Bleicher 1999). With the AIM, enterprises can lean against existing methods and models, but can also develop own forms and procedures for their innovation management. A detailed description of the AIM can be found in chapter 2.1.

Goal: enhanced innovation ability

The goal of the Integrated Innovation Management is to guarantee the innovation ability of an enterprise. It is defined as the ability of an enterprise to generate new ideas by using new knowledge or market understanding, and to successfully

[1] Amongst others, the SGMK was translated into the quality management by Seghezzi (Seghezzi 1996) and into the complexity management by Schuh (Schuh et al. 1998; AWK 2002).

put them on the market (AWK 1999). Thus, the innovation ability of a producing enterprise is measured as the share of new products of the business activities based on the average product lifetime (Brockhoff 1985). This relative evaluation is much more meaningful than the consideration of the pure share of sales of new products, which generally misjudges enterprises of branches with short product lifetimes as capable of innovation (Eggers 1993). Whether future product innovations primarily refer to incremental improvements – e.g. perfective maintenance – or radical innovations – e.g. usage of novel technologies – is strongly influenced by the orientation of the innovation management.

Grade of Novelty of products: technical evaluation

In this context, the issue is to evaluate the novelty of products. On the one hand, the focus of the evaluation can be purely technical. Thereby, the grade of product innovation is evaluated according to the state of the art[2]. But this perception is lacking particularly in in-house perspectives.

Holistic evaluation

A holistic view concerning the novelty of a product requires a concurrent consideration of external and internal factors. The innovation portfolio includes both, internal, enterprise-specific and external factors given by the market (Brandenburg and Spielberg 1998). This is explained in chapter 2.2.

[2] Altschuller for instance distinguishes between five invention levels, from "partial solution" to "discovery" (Altschuller 1984).

2.1 The Aachen Innovation Management Model AIM

The Aachen Innovation Management Model AIM was developed at the Fraunhofer IPT with reference to the St. Gallen Concept of Integrated Management. It represents a reference framework for the issues of innovation management and enables identifying integration gaps and main focuses for adjustments.

Starting from the vision, which is based on the enterprise philosophy, the sum of horizontal and vertical perspectives forms the integrative and holistic reference framework of the AIM. The goal of the AIM is to achieve stable innovation ability (Fig. 2.1). Within the decisive field of activities and its detailing by means of influencing factors, enterprises are able to position themselves. Another step of the model enables the statement of the nominal condition, which is oriented towards the corporate development. Due to the discrepancy between the nominal and the actual condition, strategic needs for action and the corresponding goals can be educed. The result is a holistic innovation management oriented towards the corporate development.

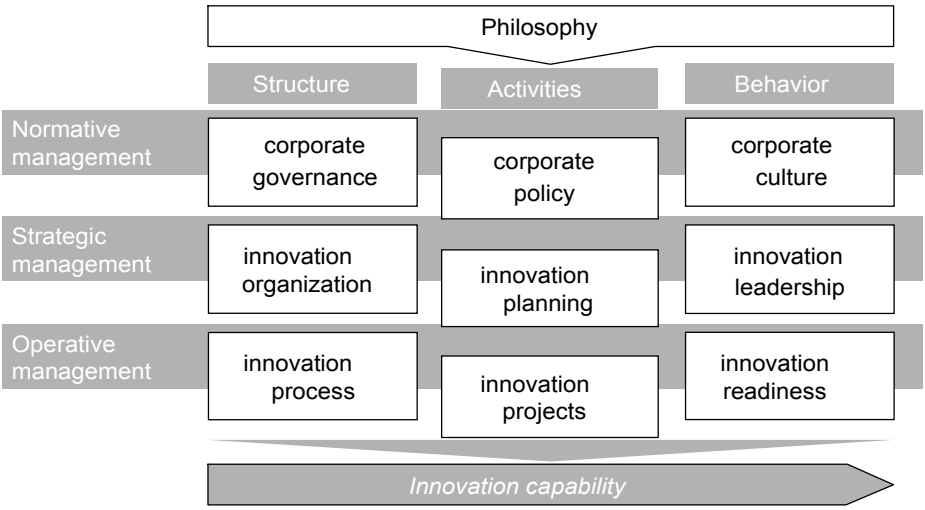

Fig. 2.1 The Aachen Innovation Management Model AIM (cf. Bleicher 1999)

The "lodestar" for the entrepreneurial business is the management philosophy. It comprises the basic settings,

Management Philosophy

convictions and values that affect the way in which the managers of an enterprise plan and act (Ulrich and Fluri 1992). The horizontal level consists of the normative, strategic and operative management. Normative and strategic management form the conceptual framework, where the situational direction of the operative management takes place.

Structures, behavior, activities

Additionally to the horizontal approach, management levels can be differentiated vertically as well. Structures, behavior and activities are the three pillars that pervade the normative, strategic and operative levels. They discuss the integration of conceptual and creative intentions as well as its cooperative implementation. Content-related aspects are concretized within the pillars across the management levels (cf. Bleicher 1999).

Activities

In respect of the concretion of the activities, company guidelines for the innovation management will be developed out of the normative level and will then be concretized on the strategic level by the *innovation planning*. These guidelines, which are relevant for medium and long terms, will be defined on the operative level in forms of *innovation projects*.

Structures

Within the pillar "structures", the innovation management will be legalized on the normative level and will be concretized on the strategic level by the design of the *innovation organization*. On the operative level, the structural aspect is expressed by the resource-connected procedure of *innovation processes.*

Behavior

Finally, both aspects, activities and structures, have an impact on the human behavior. On the normative level, past enterprise cultures characterize future strategic and operative actions of enterprise staff members. Thus, the normative level states the reason for behavior. The enterprise culture is concretized by the strategic level in view of the management tasks. The operative "innovation readiness" is focused on the behavior of the staff during work flow.

The following view is concentrated on the strategic level. The strategic management is targeting a sustaining advantage in the market by an intensive use of resources. This is done by the consciously created preconditions that enable the enterprise to gain prosperities in long terms (cf. Pümpin 1968). The innovation management fulfills tasks in three areas: concerning structures, it is innovation organization, concerning activities, it is innovation planning, concerning behavior, it is innovation leadership.

2.1.1 Innovation planning

The innovation planning sets the direction of impact for future innovations. It is characterized in four dimensions: the temporal alignment, the competence orientation, the external orientation and the planning framework. Each dimension is defined by two axes, which, in extreme degrees, embody typical patterns.

Temporal alignment

The *temporal alignment* of innovation planning describes the methods of planning as present-related or future-related (Fig. 2.2)

The temporal alignment follows from the time pattern and the information profile of planning activities. The time pattern is differentiated between short term and long term. The character of the available information is divided into clear cut, detailed and fuzzy, not so detailed information. In this context, information is internal knowledge concerning internal or external issues like technologies, capacities, sales figures, market situation, etc. A short-term planning horizon and detailed information lead to *present-orientated innovation planning*. *Future-orientation* follows from long-term planning with less detailed information.

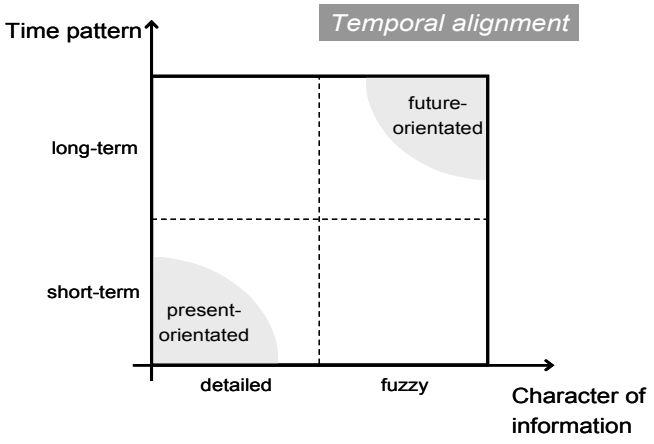

Fig. 2.2 Temporal alignment of innovation planning

Competence orientation

The competence orientation of an enterprise is another facet of innovation planning control (Fig. 2.3). The competencies of an enterprise are considered by technology and market view. A technological *competence establishment* is realized when

knowledge and abilities are acquired within new technologies – i.e. new to the enterprise. This allows competitive advantage on the long run, if the technology is at the beginning of its lifecycle[3]. Capturing unknown markets is associated with the establishment of knowledge about branch, customers, competitors, etc. Additional *market competence* is established.

The contrast to *competence establishment* is *synergy utilization*: Common technologies are used in common markets. The production of goods and services can be executed with high efficiency, which is for example verified by cost reduction, an increase in quality etc. The strategy of using synergies is suited for the establishment of competition edges and entry barriers.

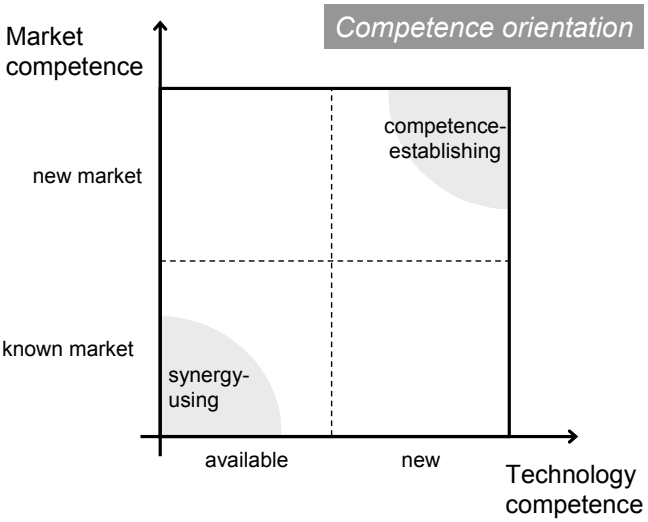

Fig. 2.3 Competence orientation of innovation planning

External orientation

The *external orientation* of innovation planning manages the general dealings of development competences related to supplier and customer (Fig. 2.4). The *supplier orientation* describes the way and intensity of collaboration with suppliers. The *customer orientation* is focused on the collaboration with customers during the product development. Supplier orientation as well as customer orientation may be of external-cooperative nature. Concerning supplier orientation, this means for example to go into development cooperation with

[3] For lifecycle models see chapter 4.5, figure 4.19.

suppliers. An example of external-cooperative customer orientation is the intensive contact with customers of a lead user cooperation[4] in an early stage of product development.

It is called an *autarkic product development*, when the cooperation with suppliers is limited to the placement of orders, e.g. production as per manufacturing drawing, and the customer is involved not before market launch, e.g. through a customer survey. In contrast to the lead user concept, the product is tailored to the "average customer" (main-stream).

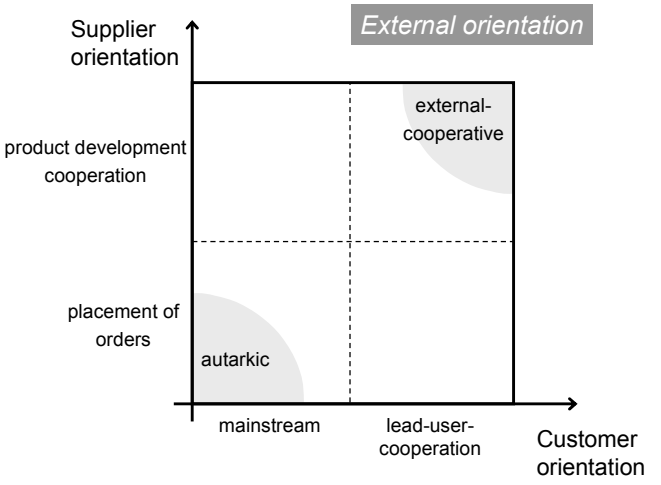

Fig. 2.4 External orientation of innovation planning

Planning framework

The forth dimension of innovation planning is the *planning framework* (Fig. 2.5). The focus here lies on the complexity of development planning tasks and on the required flexibility of development processes. A heuristic planning framework with few regulations and a problem-oriented systematic allows coping with the high complexity of the task by keeping a maximum of flexibility in the development process. The heuristic planning is suited for the solution of systematic tasks[5] that are typical for medium- and long-term innovation projects.

4 A description of the lead user concept is part of the method data sheet (appendix).

5 Systematic tasks are characterized by low structuring (that is few knowledge about essential input, targeted output, cause-and-effect-chains etc.) and less separability (high interdependency of partial tasks, interdisciplinary activities). (cf. Gassmann 1997).

Algorithmic and schematic approaches are suited just for the development planning with low complexity and low flexibility.

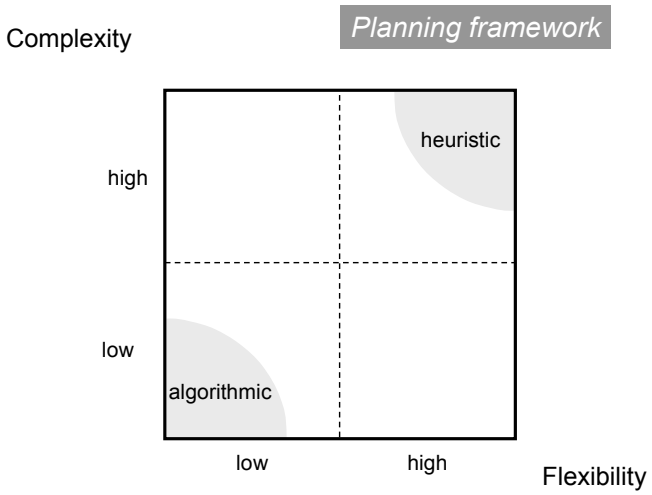

Fig. 2.5 Planning framework of innovation planning

Dimensioning of innovation planning

For the purpose of an Integrated Innovation Management, the partial strategies of the different dimensions of innovation planning have to be harmonized. This is done by illustrating all four dimensions and their values in a total view (Fig. 2.6).

Consolidating vs. changing profile

The extreme values of the dimensions of innovation planning result in two oppositional profiles: the consolidating and the changing profile. The consolidating profile (Fig. 2.6, inner circle) follows from a present-orientated temporal alignment, a synergy-utilizing competence orientation, an autarkic external orientation and an algorithmic planning framework. Enterprises with such a profile are called *Continuous Improvers*.

The consolidating profile: continuous improver

Enterprises that in the past have diversified or placed multiple new products may loose the overview, which results in insufficient attention to their product groups (Voegele 1999). In such a situation, a strategic orientation towards a consolidating profile would be a good idea.

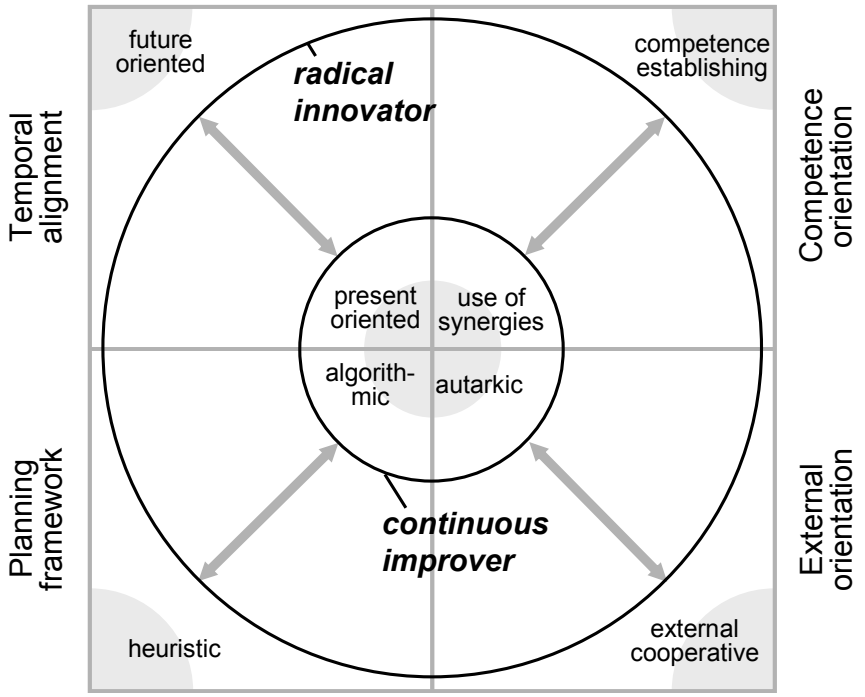

Fig. 2.6 Dimensioning of innovation planning

The major task of innovation planning is to utilize and expand the created market position in an optimal way. When utilizing existing competencies, the focus of activities lies on incremental innovations. Mainly, product management is done, and it is tried, through variant management for example, to reduce complexity and build up barriers for competitors to enter the market. Planning activities are usually present-related and should primarily address the increase of efficiency with the goal of maximizing the net-operating margin. Finally, the consolidating profile is characterized by innovation attempts with the goal of continuous improvements.

The changing profile: radical innovator

In contrast to the consolidating profile, the changing profile is characterized by a future-orientated temporal alignment, a competence orientation to establish abilities, an external-cooperative orientation and a heuristic planning framework (Fig. 2.6, outer circle).

Enterprises of such a type are called *Radical Innovators*.

If the improvement potentials of existing products are exhausted, the purpose should be to foster the next technology step or to enter new markets. At this point, it is important to shift the innovation planning to a changing profile. Cooperating with customers as well as with external research and development institutions is of avail when opening new benefit potentials. Furthermore, the changing profile is related to the goal of developing radical innovations. The appropriate planning framework is characterized by a problem-orientated and flexible approach.

Diversification

Enterprises pursuing the double strategy called *diversification*, i.e. the establishment of new competences in new markets, should be aware of the higher risks and therefore have a bankroll above average (Eversheim and Schuh 1996).

Fit of partial strategy

Both of the described oppositional types, radical innovator and continuous improver, should be seen as extremes of innovation planning. For the purpose of a holistic approach, the primary goal of an enterprise is to harmonize the partial strategies of innovation planning, i.e. to create a fit in the form of a concentric circle in the total view (Fig. 2.7).

Application in enterprises

1. Determining the as-is-profile

When applying the presented model, the enterprise is positioned in the dimensions of innovation planning. This requires the analysis of the enterprise with regard to the actual alignments of its innovation planning. For this, the partial strategies of the four dimensions (temporal alignment, competence orientation, planning framework and external orientation) are considered singularly and relatively to the extreme alignments. Because of the different distances of the analyzed dimensions to the point of origin, the arisen as-is-profile of innovation planning may have a shape different from a circle (Fig. 2.7).he as-is-profile visualized in figure 2.7 shows characteristics of the changing profile like external-cooperative orientation, future-orientated temporal alignment and competence establishing orientation. Just the planning framework with an algorithmic alignment is characterized by consolidating tendencies. Thus, a misfit towards the alignments in the other dimensions arises as visualized as a deformed circle. For the purpose of an intended, holistic and harmonic innovation planning, the misfit is not important.

2. Determining the to-be-profile...

If the partial strategies are harmonized, a concentric circle to the point of origin arises. The radius of the circle describes the overall strategy regarding the consolidating or changing profile.

3. Deriving need for action from to-be-as-is-comparison

To pursue a long-term strategy wisely, a circle-shaped to-be-profile has to be determined. Then, need for action and the aim of the partial strategies derive from the arising differences of the shapes.

Because of the essential differences of both strategies, the development of either incremental or radical innovation, the strategies should not be seen as static and permanent. Moreover, the strategy moves in an area between the poles of the extremes concerning the situational, temporal context.

Once the to-be-profile is achieved, the actual state should be kept as long as it is useful. Depending on the innovation ability and the intended level of innovation, the to-be-profile should be updated.

Direction of impact for future innovations

Thus, the innovation planning sets the direction of impact for future innovations. It updates and implements the corporate policy on the basis of the current situation of the innovation ability. This is followed by systematic developments of product and process innovations that are realized in innovation projects.

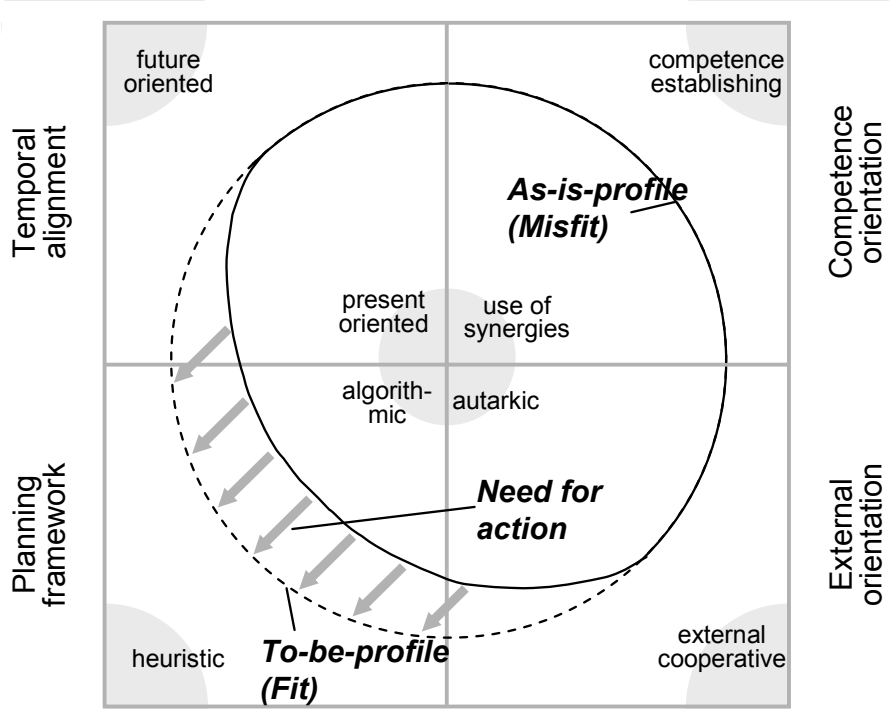

Fig. 2.7 Examples of an as-is- and to-be-profile of innovation planning

2.1.2 The innovation organization

Goal: establishing structures

The innovation organization as a structural and strategic component of the innovation management forms the framework for the innovation planning and the innovation control (cf. Bleicher 1999). The goal of the innovation organization is to establish structures that lead to an optimal innovation ability of the enterprise. Based on this goal, influence factors like *task positioning* and *information exchange* as well as *budgeting* and *resource assignment* are the dimensions of the innovation organization[6].

Task positioning

The aspect of *task positioning* distinguishes between focused and peripheral structures. Focused structures are given if a person-related orientation of the innovation task arises with the centered, organizational structuring. Radical innovations are fostered by concentrating the competencies in a central unit (Boutellier et al. 1999). The combination of task-oriented alignment with decentralized structuring is called peripheral task positioning.

Information exchange

The way *of information exchange* is often characterized as offensive or defensive. An open, internal communication and a bilateral dealing with information towards the environment – e.g. by a high presence in public – are attributes of an offensive information exchange. A defensive information exchange is characterized by unilateral and secretive dealings of information in both internal and external surroundings.

Budgeting

The dimensions of *budgeting* are aligned either autonomic or bound. Autonomic structures are characterized by a fixed annual budget for the innovation planning. A bound budgeting arises from a demand-oriented annual budget.

Resource assignment

The *resource assignment* concerning staff and time is either integrated – e.g. regarding the total innovation planning – or differentiated – e.g. regarding single innovation projects.

Dimensioning of innovation organization

Profile establishment

The consideration of the dimensions of the innovation organization in their overall context leads to a profile comparable to the innovation planning. A consolidating profile is characterized by peripheral task positioning, defensive information exchange, bound budgeting and integrated

6 Additionally, see the dimensions of R&D-organizations of Saad (Saad 1991) and the dimensions of organizing R&D-teams of Gassmann (Gassmann 1997).

resource assignment. The features of a changing profile are focused task positioning, offensive information exchange, autonomic budgeting, and differentiated resource assignment.

2.1.3 Innovation Leadership

Staff behavior

Innovation leadership aims at developing a staff behavior which supports innovation.

The following dimensions are to be considered: *staff encouragement*, *decision making*, *performance evaluation*, and *communication behavior*.

Staff encouragement

Encouragement can be related to the specialist or the generalist type of staff. For generalists, leadership and cooperation skills are promoted in particular.

Decision making

Decisions are taken hierarchically from a designated decision maker with either little feedback or in a participative manner based on decision content.

Performance evaluation

Performance evaluation can be based on results or employee development. Result-based evaluation is characterized by a narrow scope and absolute measures. In contrast, development-based evaluation is characterized by a complex set of relative measures.

Communication behavior

Communication behavior can be distinguished into integrative an excluding patterns of behavior. Integrative communication is characterized by a holistic and explanatory attitude. Excluding behavior is characterized by *ex post* directing and task focus.

Dimensions of innovation leadership

Interrelation

Innovation leadership can have, similar to innovation planning, two characteristic patterns, which contain consolidating or respectively changing properties.

The consolidating profile is characterized by professional staff encouragement, result-orientated performance evaluation, and excluding communication behavior. In contrast, a changing profile is characterized by joint decision making, development-based performance evaluation and including communication behavior. This type of innovation leadership encourages innovative behavior which is best characterized by repeatedly challenging routine processes and their evaluation regarding performance contribution.

Innovation leadership is a powerful but challenging instrument to influence innovation capability. Innovation

leadership is associated with high requirements for employees and can only be changed based on the broad acceptance of all persons involved.

2.1.4 The operational level

Operational implementation

Normative and strategic management are implemented at an operational level in innovation projects. There is also the innovation process for the structures (Fig. 2.1 left side) and the innovation willingness of the employees for the behavior side (Fig. 2.1 right side).

The task of the operational management is to transfer inputs from the normative and strategic level into practice (Bleicher 1999).

InnovationRoadMap method

The InnovationRoadMap method provides several practical tools for the operational tasks of the innovation management. In particular, it explains innovation processes and innovation projects in detail. (Chap. 3).

2.2 Innovation Portfolio

External and internal view

The innovation portfolio is based on a company-external and -internal view, which enables evaluating the innovation degree of innovation projects and products. The different views are illustrated in the innovation portfolio along the horizontal and vertical axis (Fig. 2.8). Within the internal view, there is made a distinction between the competence development and the use of synergies related to existing products and other innovation projects.

Competence development and internal use

In innovation projects, the criteria for competence development and for the use of synergies are fulfilled differently. Projects with high learning effects, i.e. with a high degree of competence development, usually do not allow making use of synergies. Products which are based on an intense application of existing knowledge, i.e. based on synergies to other products, usually do not contribute to competence development. An appropriate project selection is directed towards a balanced and situation-specific fulfillment of both internal evaluation criteria, because the success of the company is based on both, the use of synergies as well as an ongoing learning process related to the development of new competencies.

Innovation and improvement

From an external point of view, innovation projects are classified into improvements and innovations. Both, improvement and innovation are required for a company's success. Highly innovative projects always bear a risk of technical or market failure. The risk of market failure can be reduced through the simultaneous development of low-risk improvement products. On the other hand, the application of new technologies in innovative products is required because existing technologies are becoming obsolete in a specific phase of life. At this point, they only enable marginal and less profitable improvements.

Teachers, Stars, Basics, High-Risk

If company-internal and -external evaluation criteria are correlated to each other, four types of innovation projects or resulting products arise (Basics, Stars, Teachers, High-Risk). The characteristics of these types are explained in the following (Fig. 2.8).

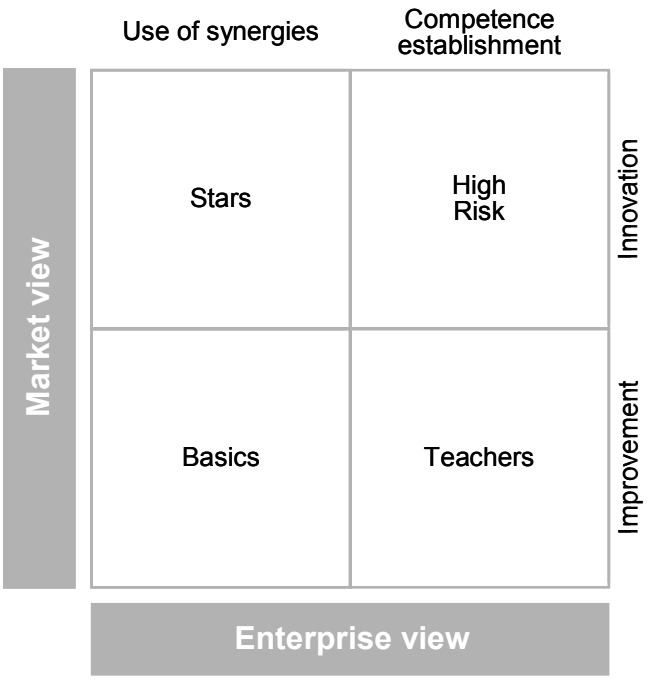

Fig. 2.8 Innovation portfolio (Brandenburg and Spielberg 1998)

Basics *Basics* result internally from the use of synergies and represent the improvement of an existing product from an external point of view. They are related with a low risk, because technical feasibility and market potential can be estimated based on company experience. In the automotive industries, the facelift of existing types is an example for the type basic.

Stars Stars are achieved internally through the use of synergies, however, they are perceived as an innovation from the external, market point of view. Due to their positive external evaluation, stars can considerably contribute to the company's success. However, they generate little internal learning. If a company generates a product for a foreign market based on its core competencies and takes over technology leadership, this product is likely to be evaluated as a star (Example: transfer of technologies from the automotive industries to two-wheeler production).

Teachers Teachers are learning projects. With these projects, internal competencies are developed, which are evaluated as improvements from an external point of view. These projects allow entering into new markets or technologies with a high

future potential. If for example a supplier aims at enhancing his competencies towards system integration and delivery, this could be initiated by realizing some teacher projects which are planned to integrate knowledge of new production technologies into the company.

High-Risk

High Risk Projects combine the risk potential from teachers and stars. Internally, they cause competency development and are perceived to be an innovation from external. The objective of a high-risk project could be to enter a new market by means of a new technology. High-risk projects can be very lucrative if they are successful. Because of the related risk, they are usually initiated sporadically[7]. (Example: the development of a four-wheel drives from a manufacturer who has produced sports-cars so far).

Balanced mix for company success

For company success, a balanced mix of all four project types is necessary. Successful high-risk projects ensure for long term company success, as they generate outstanding profitable radical innovations (Gassmann et al. 2001). Basics generate necessary cash-flow in a short term and thus balance the high risk related with the high-risk projects. Depending on the company situation, a focus can be put on the one or the other direction.

7 For the management of high-risk projects see GASSMANN (Gassmann et al. 2001).

2.3 Aachen Strategy Model for Product Innovation

The Aachen Strategy Model for Product Innovation has been developed by the Fraunhofer IPT in cooperation with the WZL of the RWTH Aachen, and is based on their experience from many innovation projects (Fig. 2.9). It is described here for the first time.

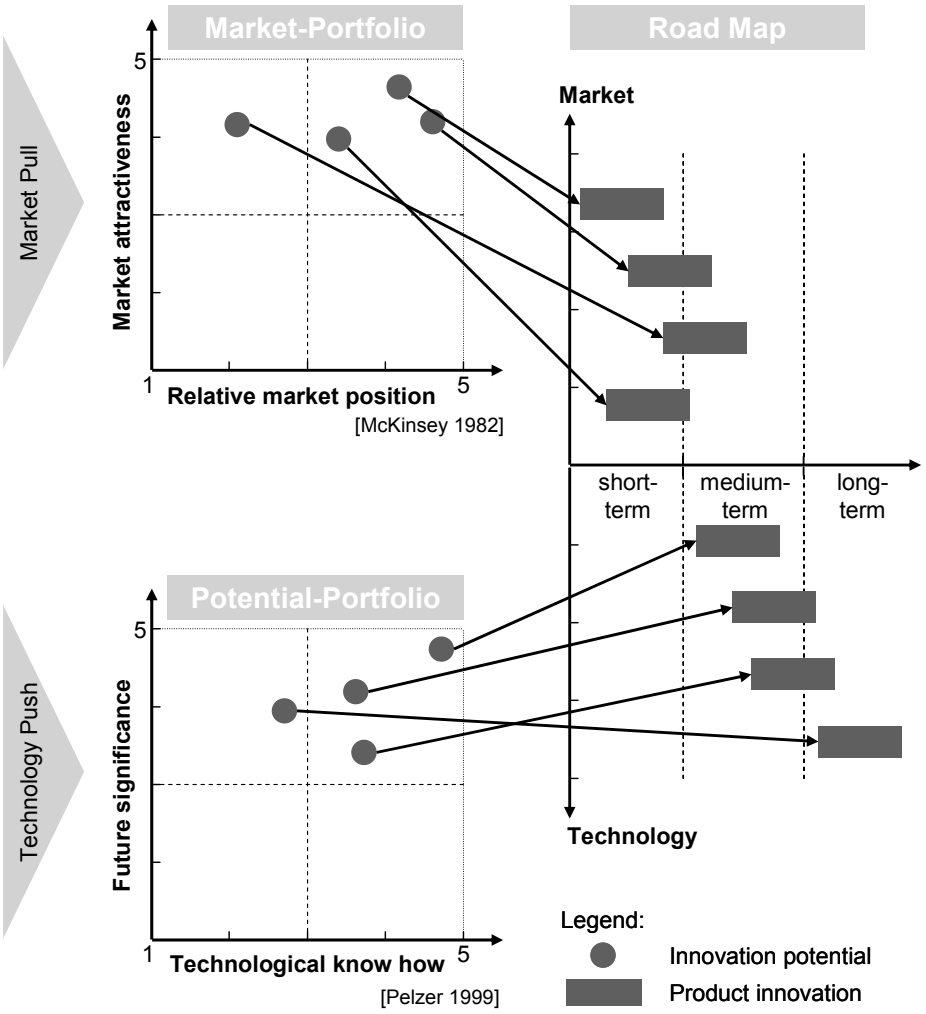

Fig 2.9 Aachen Strategy Model for Product Innovation (ASM-PI) according to EVERSHEIM

Market pull

If a company dominantly implements market-oriented strategies in order to search and select new product ideas, this generally creates short-term innovation potentials (Fig. 2.9, top). This temporal constraint can be removed partially by forecasting and auditing direct market opportunities, as well as by observing opportunities in indirect markets. A producer of camshaft grinders, for instance, has to observe precisely at what time engine developers accomplish to substitute camshafts by computer-chip-controlled-solutions (solution substitution). Engine developers have been searching for such concepts for about 30 years already.

Technology push

If a company has technological potentials, capabilities or know-how (e.g. patents/licenses), a technology push can be achieved if these potentials can be translated into product ideas. This strategy creates mostly medium- to long-term innovation potentials (Fig. 2.9, bottom).

Combined Strategy (ASM-PI)

Depending on the business targets, the branch, and the respective market position, both strategies (Market Pull and Technology Push) are used as a combined strategy. These combined strategies are summarized in the Aachen Strategy Model for Product Innovation.