
Production management I

- Lecture 2 -

Research and Development

Tutor:

Dipl.-Ing. F. Canales

f.canales@wzl.rwth-aachen.de

WZL 54b R. 503

Tel.: 80-28206



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Objectives of the lecture:

- To understand the different types of development projects
- To understand the concept and application area of the „development funnel“
- To identify the importance of the strategic management of technologies
- To identify the necessity of using tools for the strategic deduction of technological arrangements
- To know the different portfolio approaches and to be able to use them

Contents Lecture 2:

1. Contents of the lecture	L2 page 1
2. Research and development	L2 page 2
2.1 Definitions	L2 page 2
2.2 Tasks and solutions	L2 page 3
2.3 Phases of product development	L2 page 4
2.4 Break-Even-Time-Analysis	L2 page 5
2.5 Four Types of product/process development projects	L2 page 6
2.5.1 Example of platform generation	L2 page 7
3. Technology detection and prognosis	L2 page 8
3.1 Classification of technologies	L2 page 8
3.2 Sources of information	L2 page 9
3.3 Technology screening	L2 page 10
3.4 Framework for the development strategy	L2 page 11
3.5 Development funnel	L2 page 12
4. Methods of the strategic management of technologies	L2 page 13
4.1 Overview	L2 page 13
4.2 Use of technology portfolios	L2 page 14
4.3 Approach by McKinsey	L2 page 15
4.4 Approach by Booz, Allen & Hamilton	L2 page 16
4.5 Approach by Arthur D. Little (ADL)	L2 page 17
4.5.1 Technology portfolio by ADL	L2 page 18
4.6 Technology portfolio by Pfeiffer	L2 page 19
4.6.1 Example: technology „Drilling of small diameters“	L2 page 20
5. Exercise	
6. Appendix	

Bibliography lecture 2:

- Bierfelder, W.-H. Innovationsmanagement,
R. Oldenbourg Verlag,
München, Wien 1989
- Booz, Allen
Hamilton Integriertes Technologie- und Innovationsmanagement:
Konzepte zur Stärkung der Wettbewerbskraft von High-Tech-
Unternehmen, E. Schmidt Verlag,
Berlin 1991
- Eversheim, W. Organisation in der Produktionstechnik,
Bd. 1 : Grundlagen, VDI-Verlag,
Düsseldorf 1996
- Eversheim, W. Organisation in der Produktionstechnik,
Bd. 2 : Konstruktion, VDI-Verlag,
Düsseldorf 1989
- Eversheim, W.
Schuh, G. Betriebshütte, Produktion und Management,
Springer-Verlag, Berlin, Heidelberg,
New York 2000
- Grigo, H.J. Produktplanung – Theorie und Praxis
Lexika Verlag, Grafenau-Döffingen 1973
- Little, A.D.
Saad, K. Management der Forschung und Entwicklung
Strategie, Poeschel Verlag,
Stuttgart 1991
- Little, A.D. Innovation als Führungsaufgabe,
Campus Verlag, Frankfurt a.M. 1988
- Marmann,
Eversheim, W. Entwicklung einer Vorgehensweise zur Ableitung
und Bewertung innovativer Produktmerkmale,
Dissertation Fraunhofer IPT, Aachen 1996
- McKinsey & Co. Innovationskompass (VDI),
VDI-Verlag, Düsseldorf 2001
- Pfeiffer, W. Technologie-Portfolio zum Management
strategischer Zukunftsgeschäftsfelder,
Vanderhoek & Ruprecht Verlag,
Göttingen 1982
- Wheelwright, S.C.
Clark, K.B. Revolution der Produktentwicklung
NZZ Verlag, Zürich 1994

Contents of lecture 2:

Development of new products needs investments without direct income. The fact that the main part of following costs for the product is fixed during the construction makes it necessary to manage the developing process consequently and carefully. This includes a systematic and constant evaluation of new and already used technologies.

Wheelwright/Clark differentiate development projects in four types by their range of aimed modifications. Companies having a systematic R&D management pursue a well-balanced mixture of such development projects.

Technologies can be divided because of their potential for competitive differentiation and their volume of market penetration in four types: embryonic, pacemaker, key and basis technology. Different strategies are necessary to handle these different technologies and they have to be evaluated continuously.

The so-called development funnel by Wheelwright and Clark is a framework for the development strategies in companies and ensures a focusing on the important projects.

Technology portfolios are other favored instruments for systematization and evaluation of technologies in companies. During the last couple of years mainly the portfolios by McKinsey, Pfeiffer, Arthur D. Little and Booz, Allen & Hamilton prevailed.

Production management I

V2: Research and Development

- Activities of research and development
- Types of product design
- Technology classification
- Development funnel
- Technology portfolios



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Notes:

Definitions

Research and experimental development	Creative and systematic activities aim at increasing the knowledge level, including human, cultural and social sciences, as well as the use of this knowledge for new applications.
Fundamental research	Experimental or theoretic work, mainly carried out in order to gain new knowledge about the fundamentals of phenomena and observable facts without any interest for a special application or use. It is divided into applied research and experimental development .
Applied research	First-time analysis to obtain new knowledge, but concentrated on specific practical objectives.
Experimental development	Systematic work that is built on existing practical and scientific experiences and aim at the production or essential improvement of new materials, products, equipment, production processes, systems or services.

Source: OECD Frascati-handbook, Betriebshütte

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1

Notes:

Internal research and development (R&D) is very important for the **competitive position** of companies as it fixes the basics for new products and new production processes. Moreover, it provides the possibilities for the use of both, already existing and new external knowledge.

From the managerial point of view, R&D is a specific combination of production factors which is supposed to enable the extraction of new knowledge. The from the research process resulting „innovation of knowledge“ is being defined in business administration from the company's point of view and thus is not necessarily a branch or even a world innovation.

In order to guaranty a unitary data collection of R&D activities, study groups in OECD-countries have tried to determine unitary definitions.

Tasks and solutions in research and development

Task of getting market knowledge: purposes & requirements	Yet unknown market requirements /needs	Just new (eventually aroused) market requirements	Known market requirements
Technical-scientific knowledge about instruments and solutions			
Yet unknown knowledge about technical-scientific instruments and solutions	Fundamental research	Market research ↓ Demand pull	Traditional solution
Just new knowledge about technical-scientific instruments and solutions	Applied research → Science push	Basis-Innovation	New development combination of familiar purposes and new instruments
Familiar knowledge about technical-scientific instruments and solutions	Knowledge and methods data base	New development Innovative application	Imitation

Source: according to Schiele, Warnecke

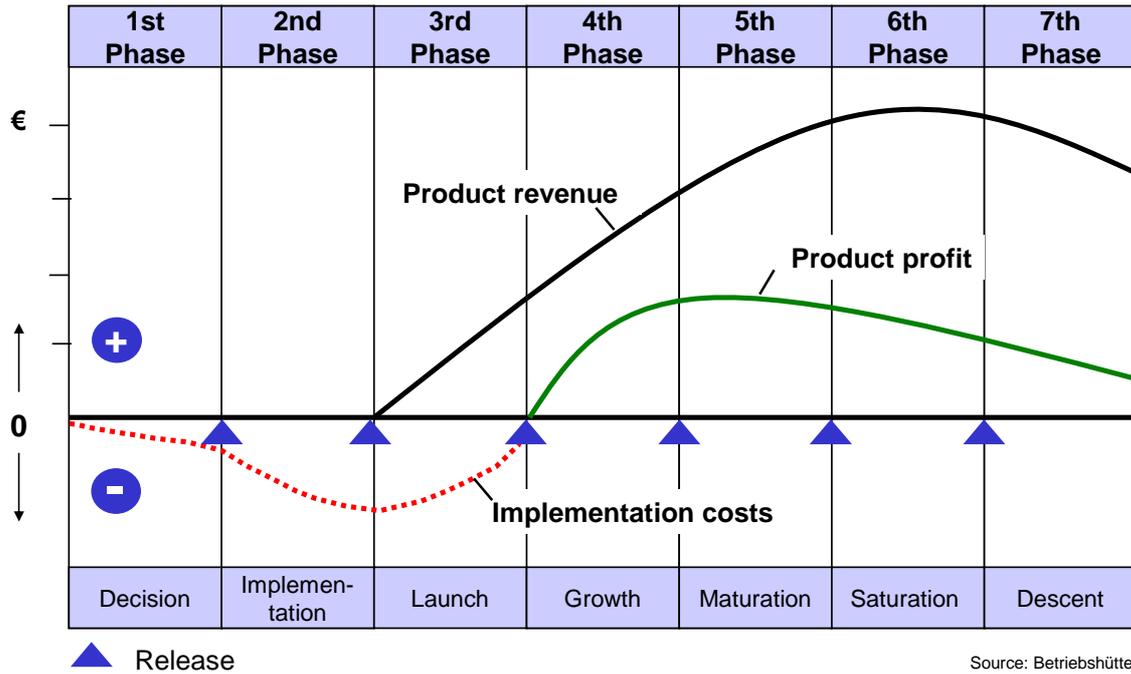


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2

Notes:

The technical-scientific progress takes place in two directions: On the one hand, new scientific cognitions bring about new products and processes and on the other hand, market needs lead to new cognitions.

Phases of product development

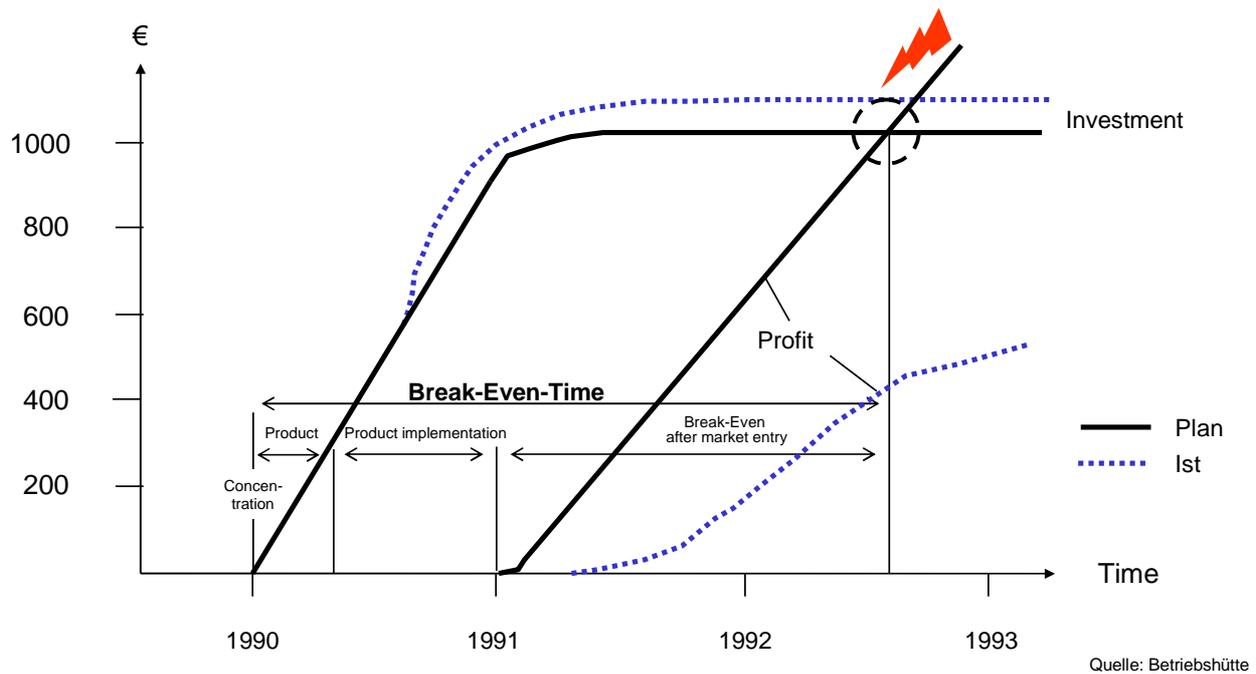


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Notes:

Depending on typical revenue and profit trends, every product is differed in **seven life phases** ranging from the product decision to the withdrawal from the market. The product revenue or profit is used as a limitation for each phase. A strong **market orientation** (=customer orientation already in the first life phases of a product as well as an efficient product development process) is an important condition for the successful planning of new products. Since every product implementation means an immense financial engagement, the product decision must assure that it is carefully prepared and adequately insured.

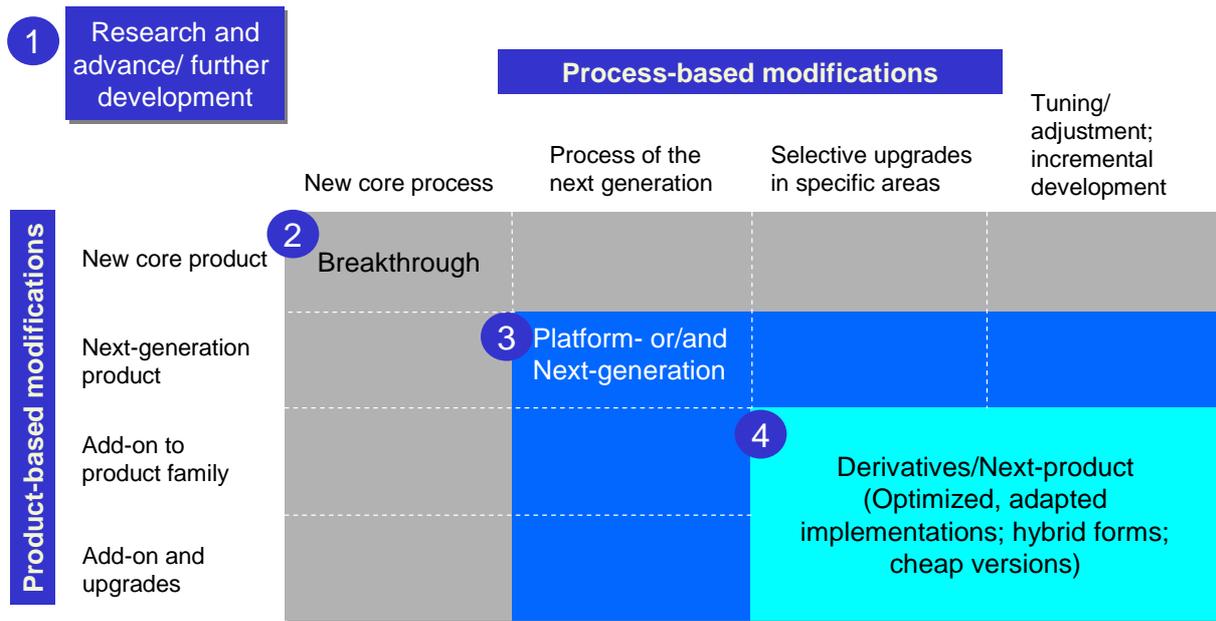
Break-Even-Time-Analysis



Notes:

One instrument to manage a development process is the **break-even-time-analysis**, which represents the consequent use of anticipated checking. The break-even-time is the period of time in the product lifecycle until the profits equal the earlier investments (development costs, costs for the preparation of the market and production, production investments for new products). Here, the controlling of development projects is directly focussed on the development time, which unveils the impacts of time lags or time reductions, respectively. The main benefit of the break-even-time-analysis is that it considers every phase of the project and that it centres every involved person on the critical **factor of success – time**.

Types of Product-/ Process development projects



Source: Wheelwright/Clark (1992)

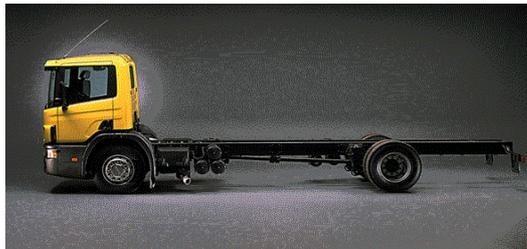


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5

Notes:

Type and size of the development project depends on the volume of the (aimed) modifications on the product and process. The project type research and advance/further development includes the proof of practicability and applicability of a new technology. The three other types of projects (breakthrough, platform/next-generation and derivative/next-product) deal with the use of approved technologies in order to generate commercial products and high technical production processes, which are able to realise the company's objectives.

Example of a platform generation



No matter what your transport needs, Scania can supply trucks optimally designed for your particular requirements. Our product range is based on modules which permit an almost indefinite number of variants to be built using a limited number of components. This approach allows us to satisfy extremely specific individual requirements while at the same time ensuring that service and maintenance are simpler and thus cheaper. We have divided our trucks into four chassis classes, according to their application areas.



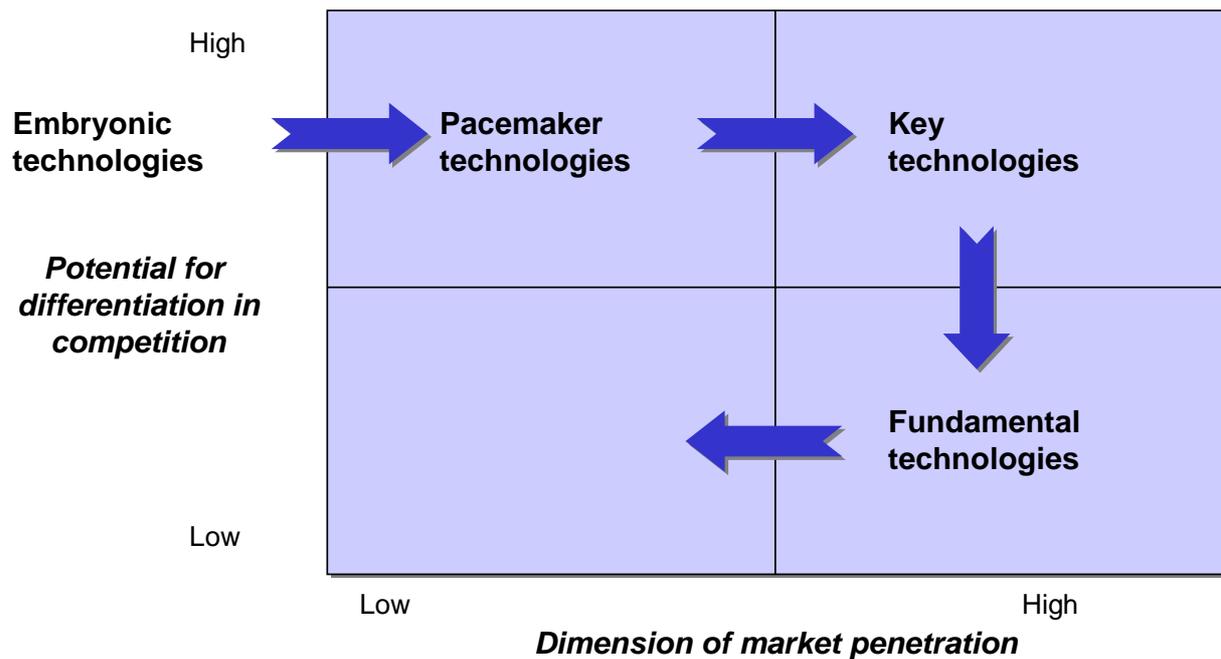
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6

Notes:

For the client, platform- and following projects mean a new system-based solution and involve significant modifications on the product and/or process. They create a basis for product and process families that can be extended for years.

If they are planned and implemented accurately, platform projects constitute an important volume basis (many different variants of one platform) and create major improvements in costs, quality, performance and functionality (compared with the former generation). For this reason they are often called „next-generation“ projects.

Classification of technologies



Notes:

In business economies and many companies' technology management there is actually a standard **classification scheme** established. This classification scheme bases on a lifecycle model, which classifies technologies by their level of maturity. In each of these stages the technologies provide the companies involved in the development different possibilities of differentiation in the competition. On the other hand, however, the companies have to choose between different strategies. These are...

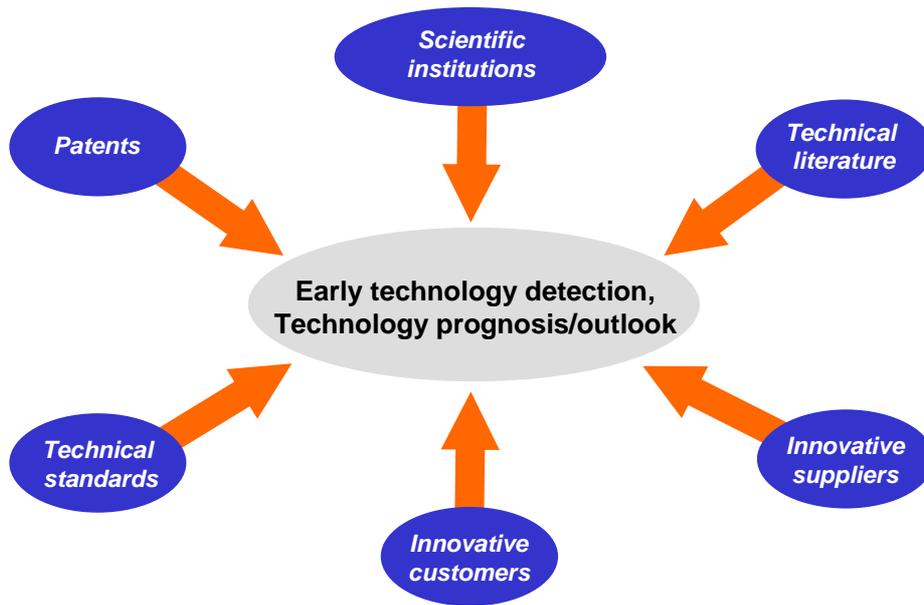
Key technologies, i.e. technologies that are already established in the market and give strong advantages in competition to the companies mastering them;

Pacemaker technologies, which are (probably) going to establish themselves in the market and promise high (latent) competitive advantages to the companies involved;

Fundamental technologies, which are already established in the market and have to be mastered by the relevant competitors without providing any explicit advantages of differentiation;

Embryonic technologies, which are partly conceivable today, but still need a lot of preparatory work in basic research and represent high risks.

Sources of information



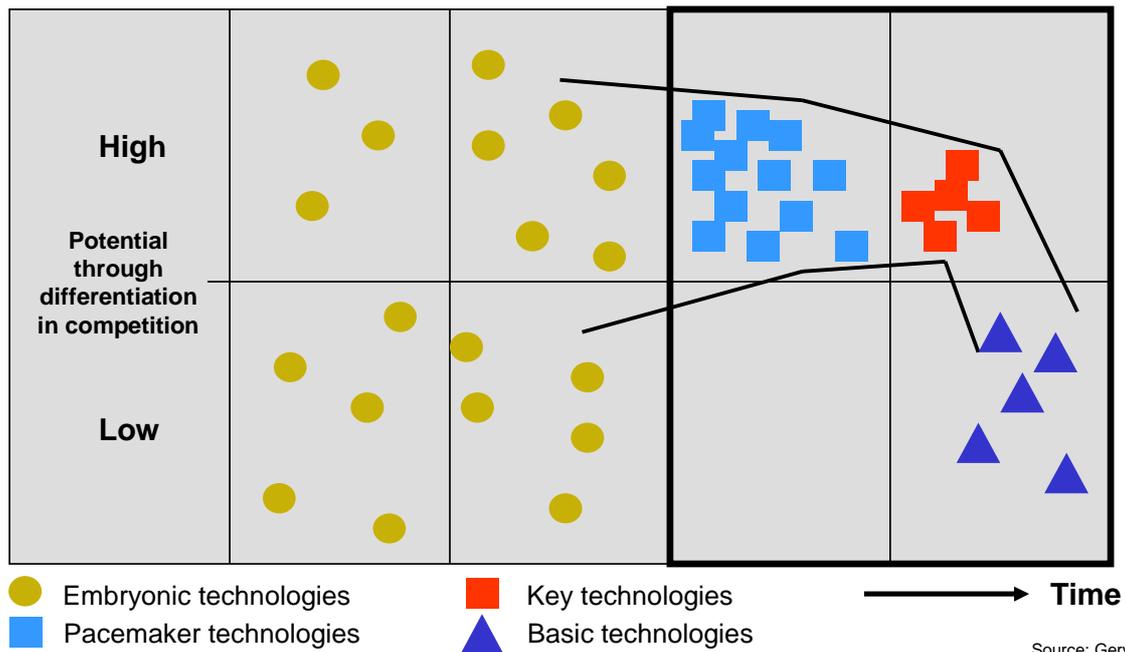
Notes:

The early **technology detection and -prognosis** is aimed at identifying and interpreting technology relevant signals in the companies' environment in order to create an information basis for decisions about technological innovation activities.

Among the most important sources of information for this task are:

- innovative suppliers,
- innovative customers,
- technical literature,
- scientific institutions,
- patents,
- technical standards

Technology Screening



Source: Gerybadze



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9

Notes:

In order to gain a leading position in technology development it is necessary to record even weak signals of up-coming technologies. It is important to record and advance only those technologies, that are really relevant for the specific company. This process can be visualised as a funnel showing some decision items for the selection of relevant technologies.

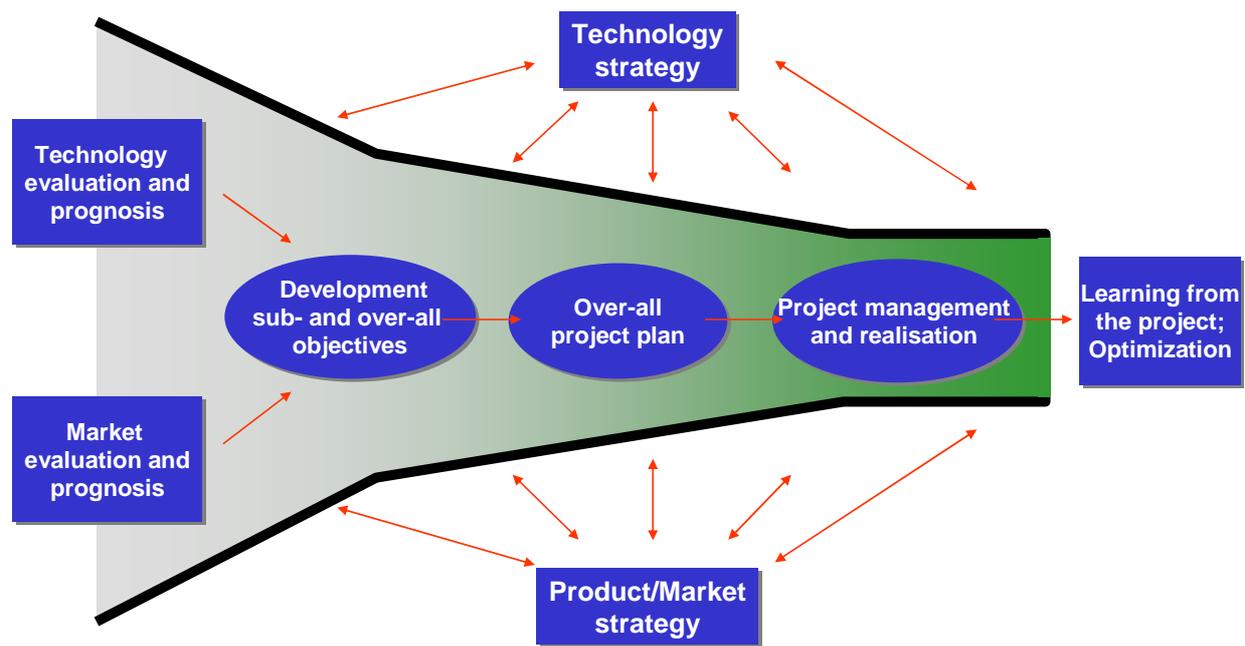
Monitoring:

Internal and external observation of the specific relevant technologies.

Scanning:

Observation of „weak signals“ concerning new technological solutions for existing problems.

Framework for the development strategy



Source: Wheelwright/Clark (1992)

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10

Notes:

In the framework for development strategy proposed by Wheelwright/Clark, **technology strategy** on the one hand and **product/market strategy** on the other hand play a key role in focussing the development efforts on projects that contribute to achieving the predetermined development targets (sub- and over-all-objectives). Thus, the single projects are always part of a project series, which not only realises strategic targets but also offers the opportunity for systematic learning and optimisation.

Strategic guidelines for R&D projects are:

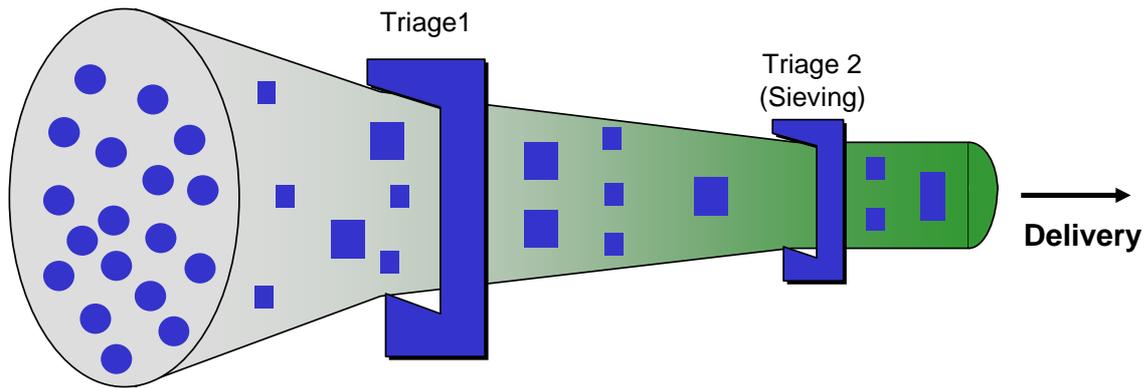
R&D subject determination: In which cases are technologies and/or R&D projects critical for advantages in competition, company know-how, know-why, advantages in competition because of a unique combination of know-how and know-why?

R&D focus: Concentration on these targets/characteristics of products/processes, in which the company has a unique advantage.

R&D resource: What is the role of external and internal resources? How are external and internal resources integrated?

Time/frequency: Rapid-inch strategy, Great-Leap Forward, ...

Development funnel



Phase 1

Extraction of product/process ideas and concept development (including advance-/further development, identification and verification)

Phase 2

Detailing of the suggested project limits and the required know-how

Phase 3

Efficient execution of different kinds of focused development projects

Source: Wheelwright/Clark (1992)



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11

Notes:

Wheelwright/Clark describe different models of their so-called development funnel. According to them, the picture above shows the „perfect development funnel“. The large front part, input area (**Phase 1**), allows as many ideas as possible to enter the funnel. After the first screening the best project ideas are handled in detail, analysed (**Phase 2**) and made determinable. The next step is the second screening (Go/no-go). Here, the passing (approved) projects are equipped and – within the scope of a focussed enterprise – rapidly launched on the market (**Phase 3**).

Methods of strategic management of technologies

- Technology portfolios by McKinsey&Company
- Technology portfolios by Booz, Allen&Hamilton
- Strategic management of technologies by Arthur D. Little (ADL)
- Technology portfolios by Pfeiffer



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12

Notes:

Benefit of technology portfolios

- Manageable illustration of the actual situation
- Basis for the formulation of technology strategies and the main R&D fields
- Intelligible communication instrument for strategic planning
- Integration of technology and market view



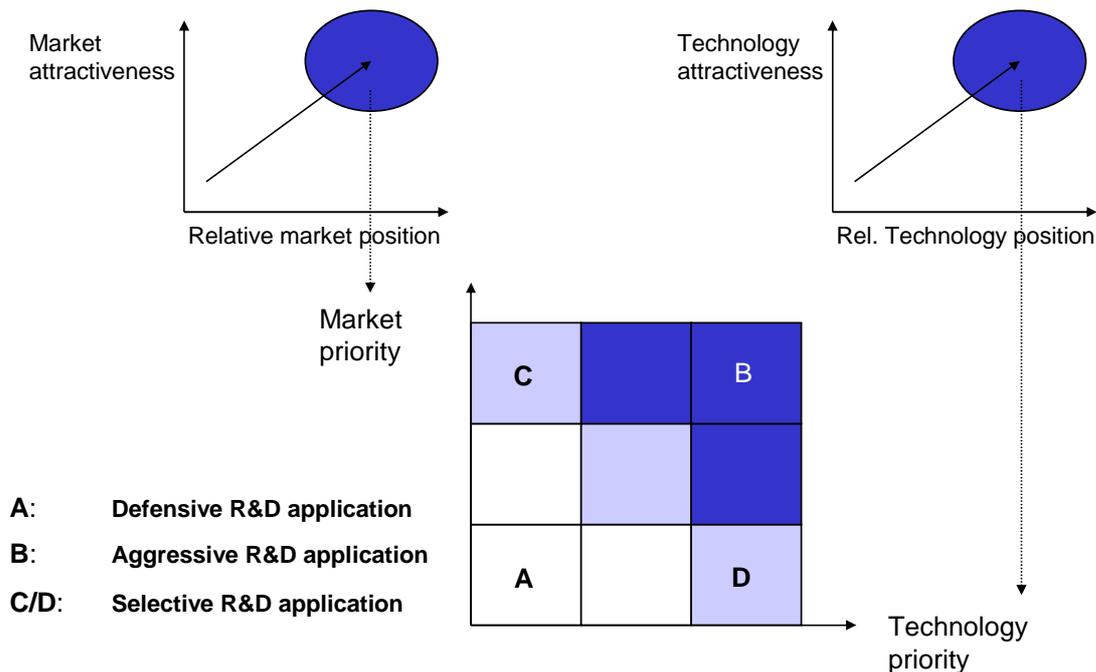
Notes:

„An estimation of the future conditions depends on the companies' constant efforts by the identification, combination and decipherment of relevant trends. It turns out that market chances result mostly in the point of interception of trends affecting the market, technology and competitors. Market trends represent chances fulfilling authentic client wishes or necessities. Competitor trends permit conclusions of market chances. Often it occurs by the disclosure of blind spots in the competition. Technology trends point out opportunities for adding value through new products and processes“

[Dechamps et al. 1996, page 133]

The technology portfolio method reproduces not only the actual situation clearly, it is also an effective instrument for an easy integration of the technology and market view.

Approach by McKinsey



Notes:

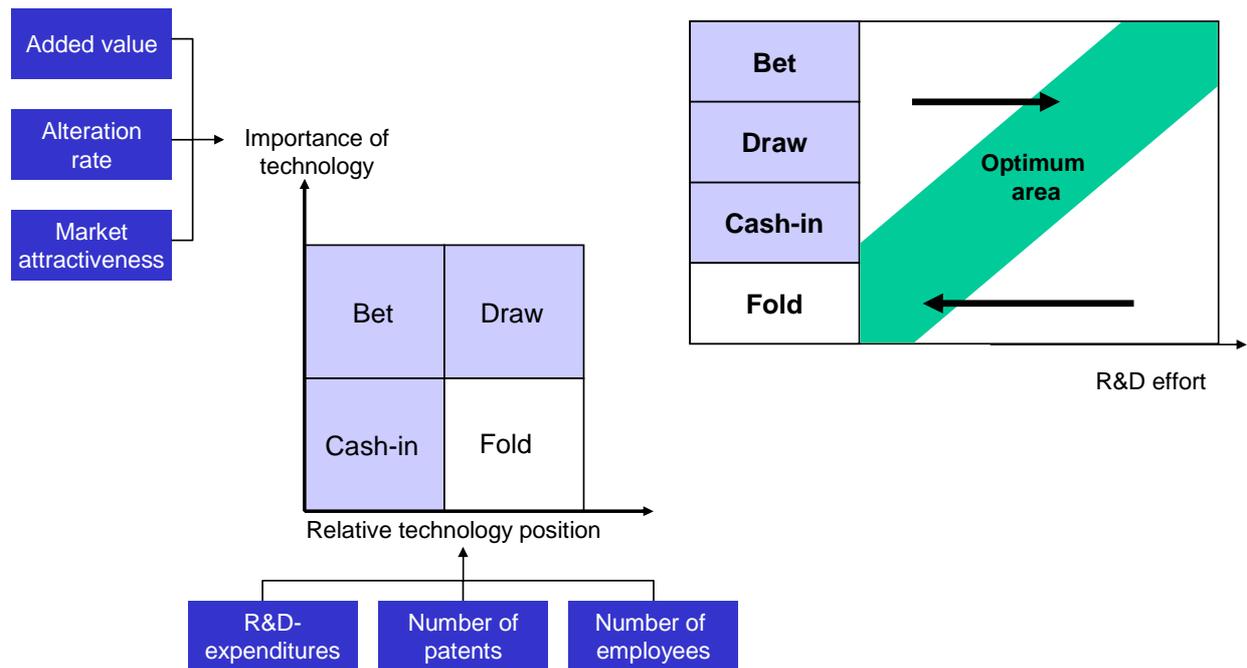
Depending on the environmental conditions a company works in, the strategic decisions deal with the long term concentration of R&D activities. Therefore, technological prognosis and technology portfolios are necessary. Portfolios are two-dimensional diagrams, one axis influenced by the company, the second axis by the environment of the company.

The **portfolio approach by McKinsey** tries to quantify the exploitation of technological potential from products and production processes. This is based on the S-curve-concept, according to which the efficiency of a technical system progresses with the income. The confrontation and combination of the technology and market portfolio in an integrated portfolio allows the analysis of technologic strategic calculus.

The procedure to develop the technology portfolio is structured in four steps:

1. Identification of important technologies
2. Classification of the technologies in the technology portfolio
3. Classification of the business segments in the market portfolio
4. Combination in an over-all portfolio and deduction of R&D priorities

Approach by Booz, Allen & Hamilton



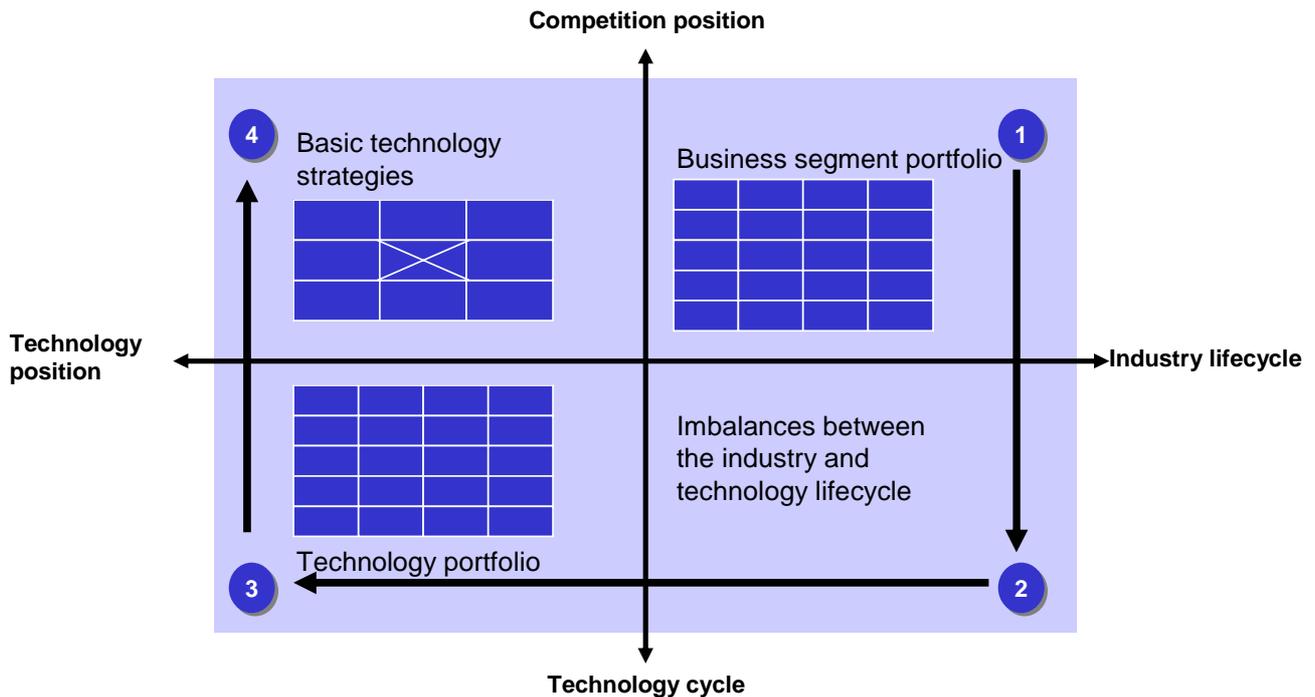
Notes:

The portfolio approach by Booz, Allen & Hamilton links technology investments and company strategy by listing the relevant technologies per business segment and classifying them in the portfolio. It aims at acquiring investment priorities based on the actual technology situation of the business area.

The analysis is structured in four steps:

1. Evaluation of the technologic basic item
2. Development on a technology portfolio
3. Integration of technology and company strategy
4. Deduction of priorities for technology investments

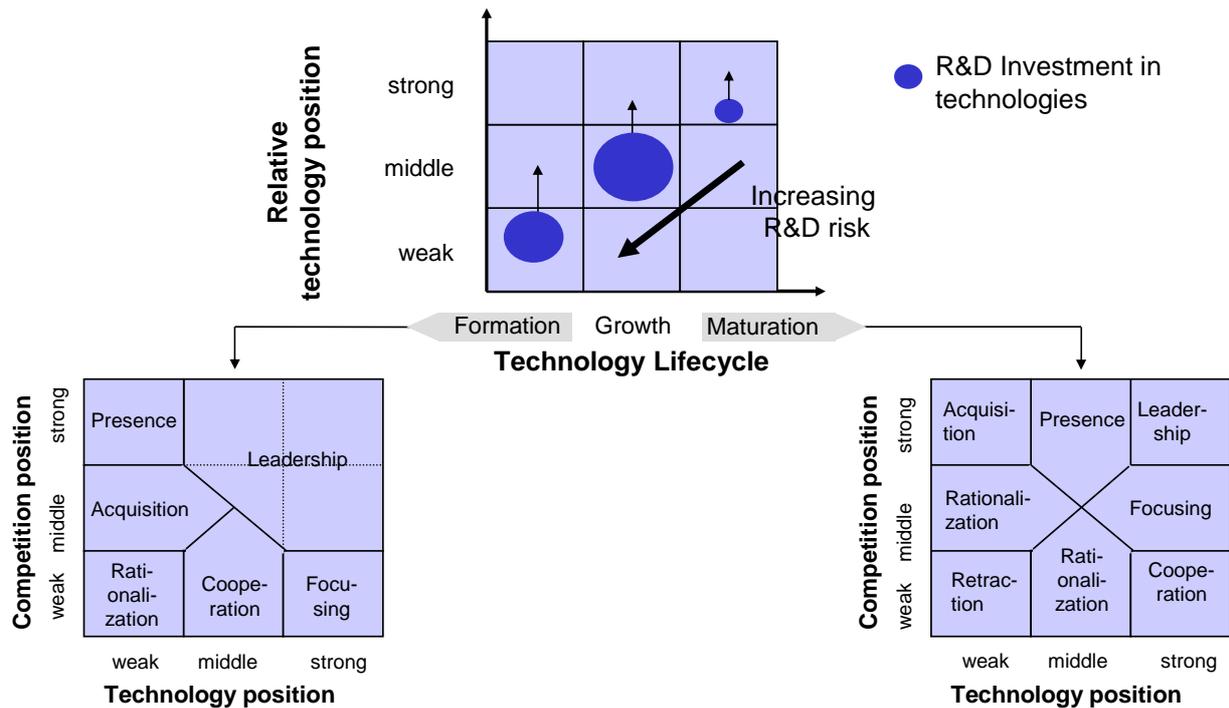
Approach by Arthur D. Little (ADL)



Notes:

The portfolio model by ADL aims to deduce technology strategies. It assumes that the cycles of technology and business segment are not congruent. The basis for the decision between the technological-strategic options is on the one hand an analysis of the technological position and the position in competence of the strategic business segments, and on the other hand, an analysis of the lifecycles of the technologies and of the respective branches.

Technologyportfolio by ADL



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17

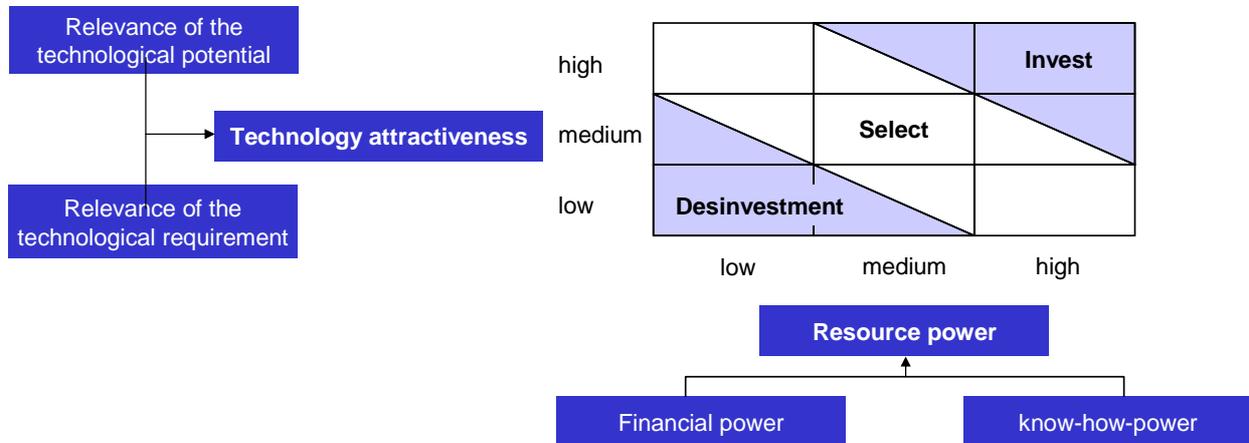
Notes:

The single steps are:

1. Classification of the technologies
2. Identification of the company's technological position
3. Positioning of the technologies in the portfolio
4. Deduction of R&D priorities and risks
5. Confrontation of market and technology position
6. Deduction of technology strategies

Strategy references are given in two different portfolios because in early phases of a branch development, technologies have a higher importance in competition and companies have a broader scope. However, there are no references given for the innovation timing.

Technology portfolio by Pfeiffer



Notes:

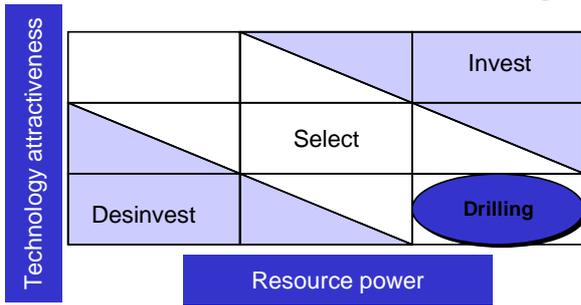
This approach includes the development cycle which takes place, seen from a temporal point of view, before the market cycle, as well as the observation cycle, which strategically analyses two dimensions: the technology attractiveness and the resource power. The approach is based on the presumption, that by parallel expanding development cycles and contractive market cycles, the innovator may achieve a larger sales volume than the imitator. Therefore, it is recommendable to execute early investments in relevant technologies and to follow a pioneer strategy.

The different steps are:

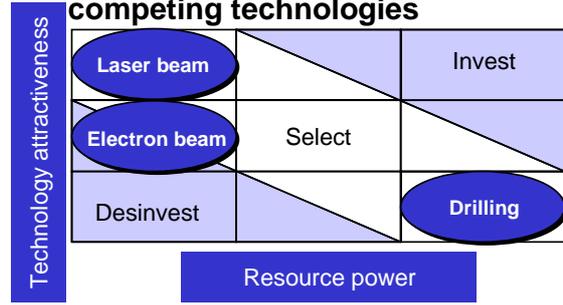
1. Identification of technologies
2. Identification of technology attractiveness and the resource power
3. Transformation of the present technology position into a target portfolio
4. Deduction of recommendations for activities.

Example: Technology “Drilling of holes with small diameters”

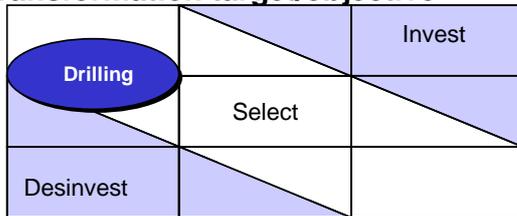
1. Classification „mechanical drilling“



2. Including future competing technologies



3. Fixing and evaluating a transformation target/objective



Notes:

The technology used „mechanical drilling“ defines the position of the technology field “drilling” in the company.

By integrating the future competing technologies, a critical technology position is obvious.

Trough the transformation due to the adoption of auspicious technologies, a new future position is generated. In this case it is critical that the projected technology position shows a low resource power.