R&D Project Management in the Chemical Industry

The following collection of PowerPoint® Charts is intended to further clarify and supplement the relevant specialist publications on the subject matters dealt with. This collection in no way is used for any commercial purposes, but as learning material for students.

Selected sources for in-depth studies of the respective subject matters are given in some lists of references.

The chemical-technical target components, formulas, deadlines, data, project structures and action plans shown in project examples P1-P3 are widely with a practical orientation, but yet purely fictitious. They are solely used for a clear illustration of the particular topic and for learning purposes.

The names of all persons with project functions are solely fictional. Matches with the names of other people would be purely coincidental.

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The Subject Matter

- Innovations: Characteristics, Measures for its Promotion, Process Variants.
- Three Examples for Innovation Projects (Chemistry and Technology):
  1. Highly Elastic Clear Coats for the OEM Automotive Sector.
  2. Nitrilase Catalyzed Synthesis of a Chiral Hydroxy-Carboxylic Acid.
  3. New Metal-Organic Frameworks for the Adsorptive Storage of Gases.
- Projects, Target Systems, Project Management in R&D.
- Appropriate Organization and Effective Structure Planning of R&D Projects.
- Project Flow Planning, Milestones, the Stage-Gate®-Process, Network Diagrams.
- Effective Implementation and Control of R&D Projects, Trend Analyses.
- Success Risks: Identification, Classification and Treatment.
- Recruitment and Lead of Project Staff:
  Chemists (m/f/d) – Team Players, Pacemakers and Executives in Projects.
- Project Manager (m/f/d): Tasks, Leadership Functions and Personality Profile.
- **The Systematic Evaluation of Individual R&D Projects.**
- R&D Strategy: The Planning of a Project Portfolio.

R&D Project Management in the Chemical Industry

Subject Matter →

The Systematic Evaluation of Individual Research Projects.

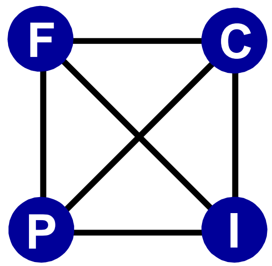
The Systematic Evaluation of Individual R&D Projects

The Project Scorecard (P. SC.) for Individual R&D Projects.

Project Financing (F):
How do we design our finances and resources to satisfy both, our principals and customers?

Customer Integration (C):
How do we want to involve our customers in order to achieve our project goals optimally?

"Strategy-Simplex" →



→ (K_4): $\begin{bmatrix}4\\2\end{bmatrix}$

Project Flow (P):
Which processes in the project do we have to optimize in order to quickly realize the target system?

Innovation/Learning (I):
How do we want to sustainably use our project learning experiences as "Lessons Learned"?

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The Systematic Evaluation of Individual R&D Projects

The Project Scorecard (P. SC.) for Individual R&D Projects.

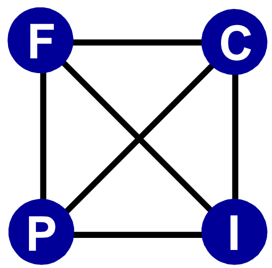
Project Financing

Targets			
Key Figures			
Measures			

Customer Integration

Targets			
Key Figures			
Measures			

"Strategy-Simplex" →



→ (K_4): $\begin{bmatrix} 4 \\ 2 \end{bmatrix}$

Project Flow

Targets			
Key Figures			
Measures			

Innovation/Learning

Targets			
Key Figures			
Measures			

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The Systematic Evaluation of Individual R&D-Projects

The Methods for Evaluating Individual R&D Projects:

Project evaluation from a **strategic** point of view. →	Technology Position/Potential Market Position/Market Attrac-tiveness, Project Scorecard.
Project evaluation from an **economic** point of view. →	Assessment of Net Present Value (NPV) and Expected Commercial Value (ECV).

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The Systematic Evaluation of Individual R&D Projects

Capital Value, Net Present Value (NPV), Purpose:

Important figure for the **profitability analysis of R&D projects**. It provides assistance in the case of current R&D investment decisions (project start: yes / no) (project continuation: yes / no) and **portfolio plannings** with several R&D projects to be compared among each other.

Its calculation is particularly reasonable for R&D projects: In these are the different periods for project-related **"Cash-Outflows" (In particular R&D expenditures)** and the periods of time for project-related **"Cash-Inflows" (In particular revenue through successful market introduction)** clearly separated from each other.

This is always the case for R&D projects: In the initial phases "business case", "lab-phase", "pilot phase", the costs (salaries for laboratory personnel, equipment, analyses, chemicals) are very high. Compared to this, the "revenues" (E.g. by "negative taxes", therefore tax savings) are negligible.

Capital Value, Net Present Value (NPV), Purpose:

The NPV delivers **a dynamic, future-oriented** and real balance sheet on the respective reporting date: In a current project, the correspon-ding **discounted** values of the foreseeable revenues (Capital return, cash inflow) are added to the **discounted** foreseeable expenses (Capital-need, cash outflow). Both, the discounted cash-inflow and the discounted cash-outflow, are calculated separately and netted for every subsequent year.

Advantage: Both, the planned annual cash-inflow and cash-outflow have a **uniform**, interest-adjusted **reference point**.

The NPV is always aimed from the reporting date into the future! Expenses from the past are not relevant to the decision and are not considered **("Sunk Cost Principle")**.

The Systematic Evaluation of Individual R&D Projects

Procedure for Determining the Net Present Value (NPV):

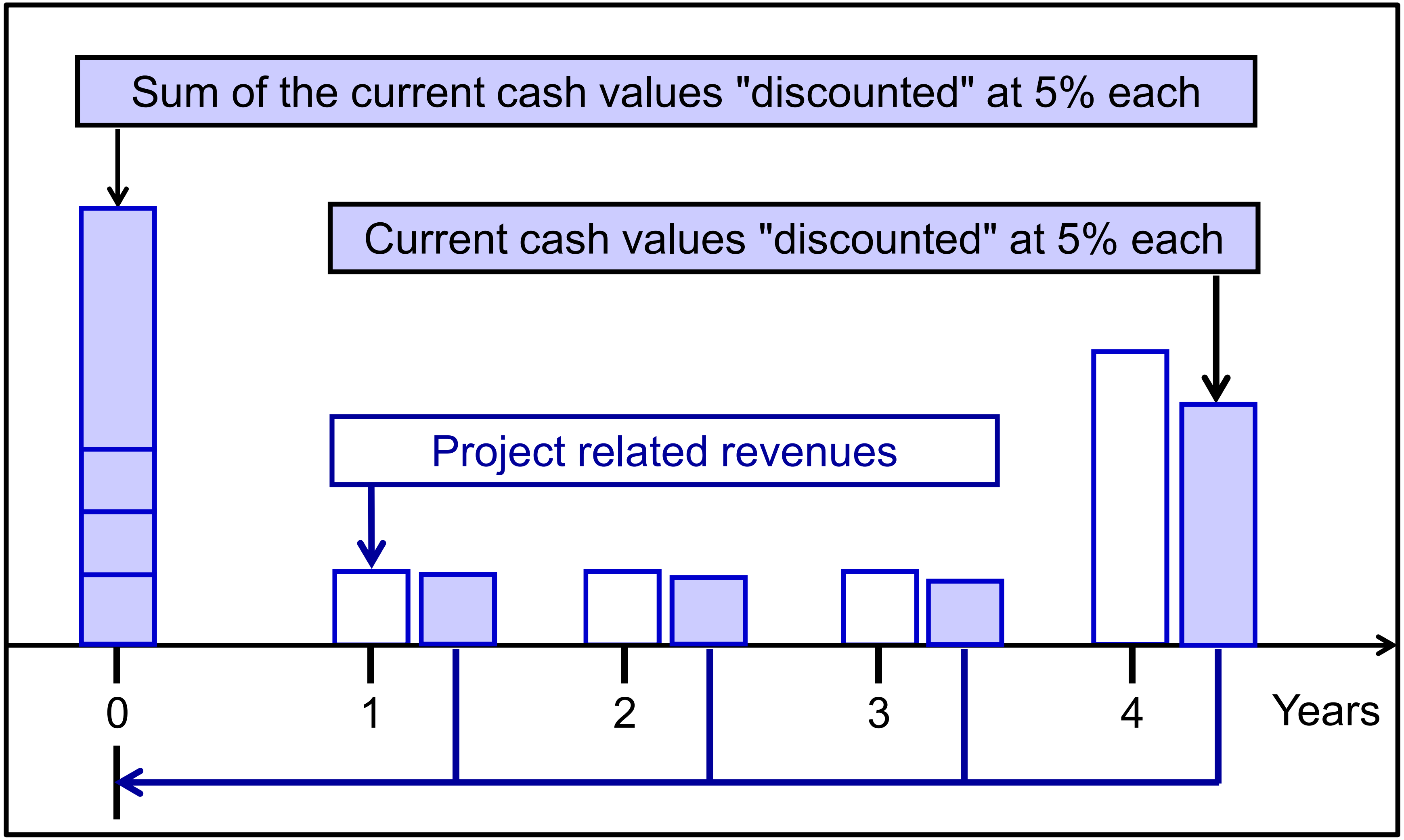
The net present value is calculated for a *key date* **(Today)**. For this purpose, the currently *foreseeable* **project-related future revenue (Capital returns: "Cash-Inflow")** and **expenses (Capital expenditures: "Cash-Outflow") are accounted** for all at once, as if they were already effective today.

The NPV is calculated by referring the sum of all future project-related, **discounted revenue to today** and subtracting from this sum all future, project-related **expenditures**, also **discounted to today** for reasons of comparability. In addition, an immediately due - and therefore not interest-adjusted - "initial deposit" (E. g. apparatus purchase) will be deducted.

In order to calculate *today's discounted present value*, the individual time-differing contributions to revenue and expenses are each calculated with a **beforehand agreed** interest rate per year (Example here: 05% discounting per year).

The Systematic Evaluation of Individual R&D Projects

Capital Value, Net Present Value (NPV), Revenue:



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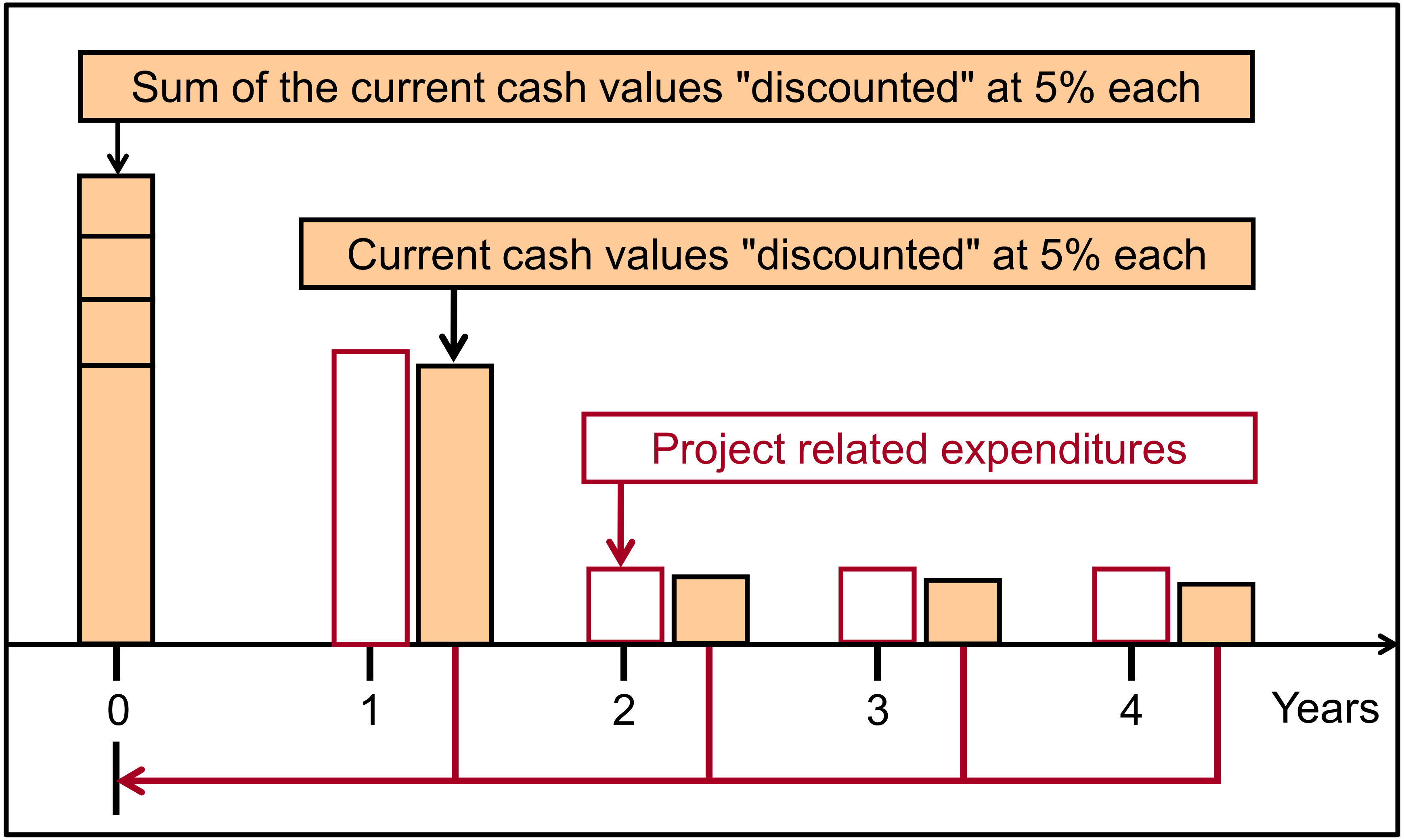
The Systematic Evaluation of Individual R&D Projects

Capital Value, Net Present Value (NPV), Expenditures:



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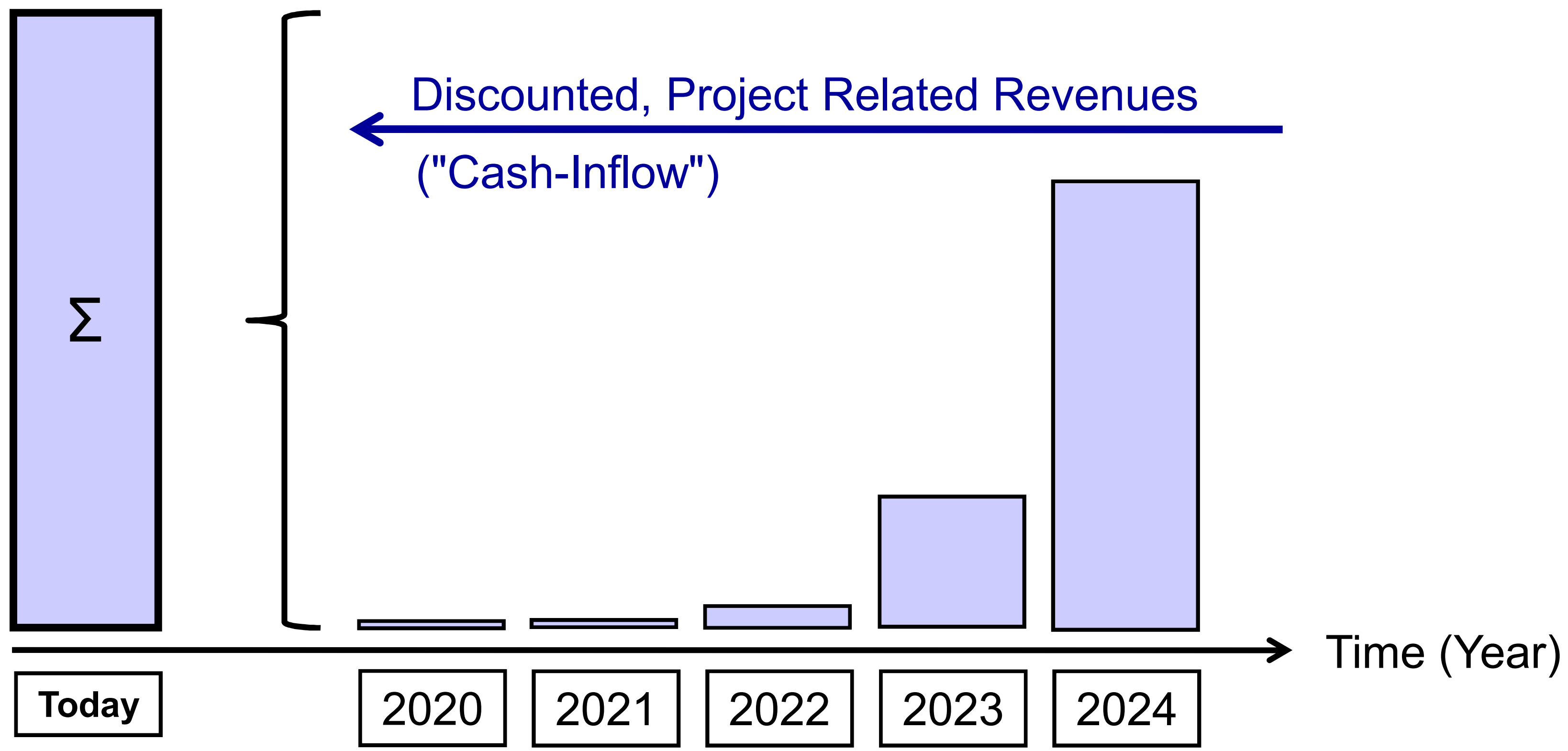
The Systematic Evaluation of Individual R&D Projects

Capital Value, Net Present Value (NPV), Revenues:



Revenues: Estimated, discounted and totalized **project revenues** or **savings** per period (year).

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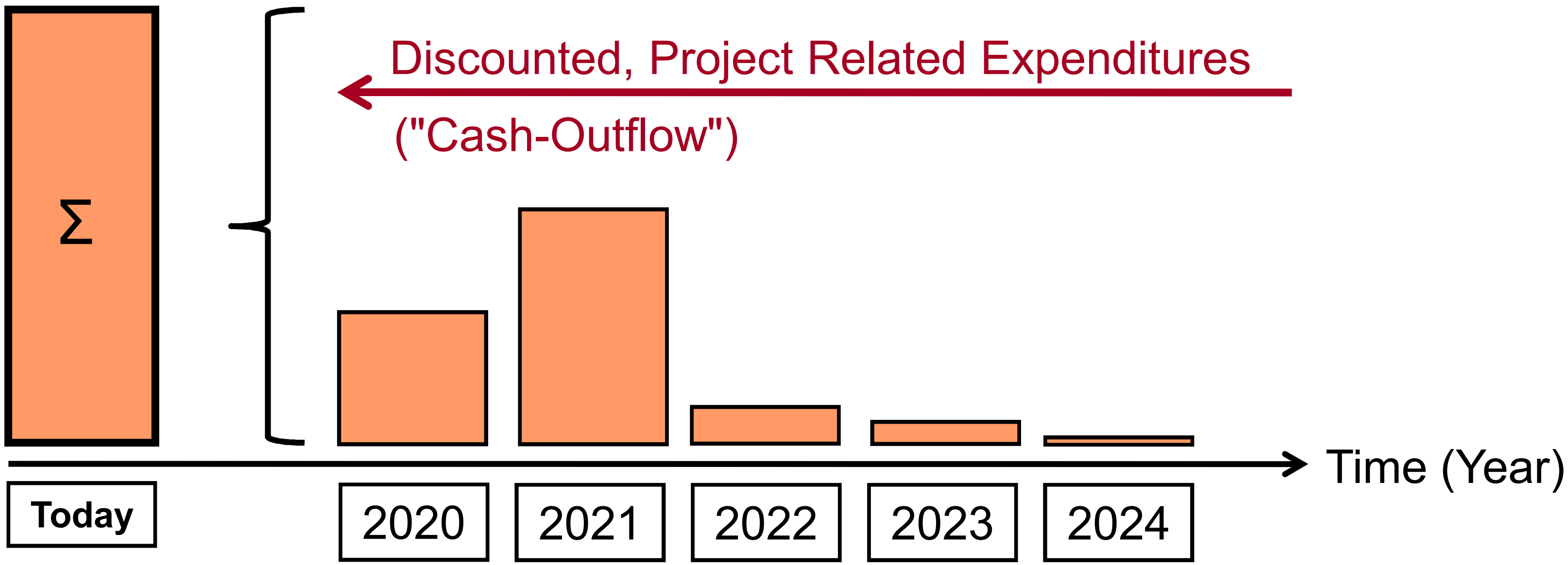
The Systematic Evaluation of Individual R&D Projects

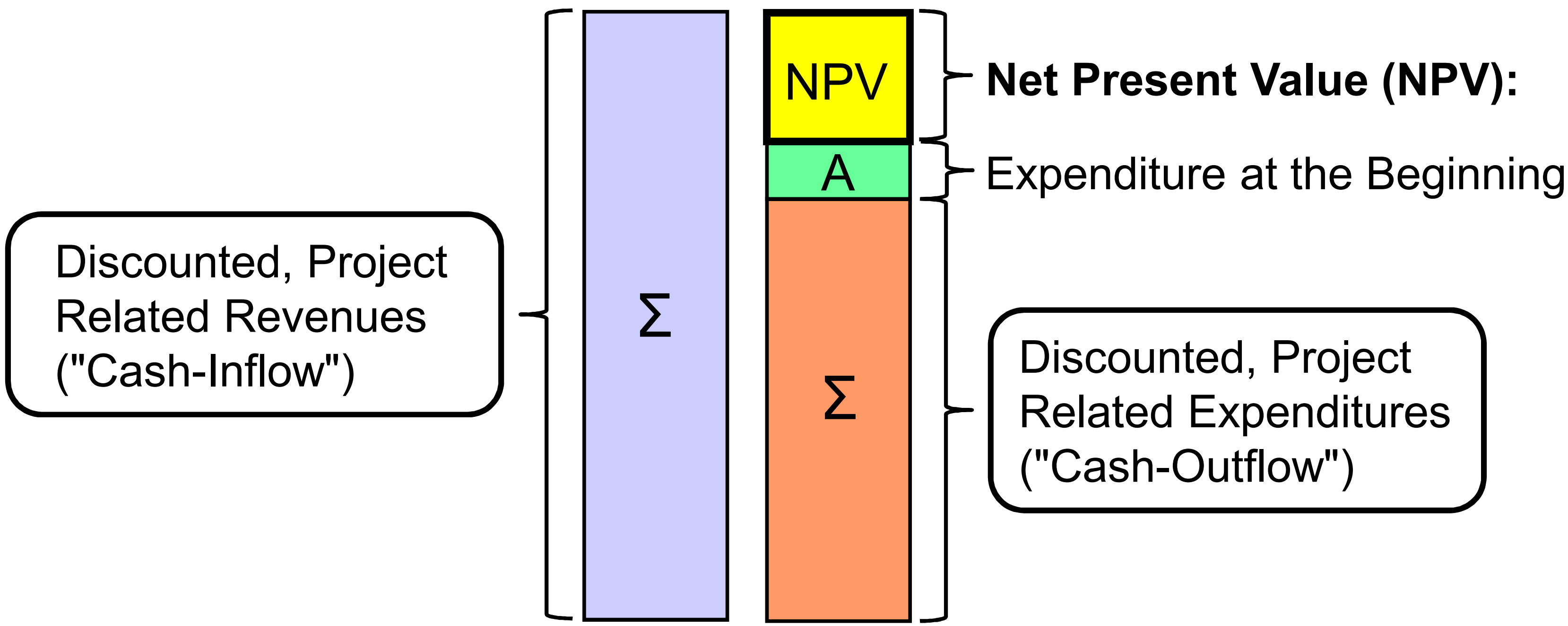
Capital Value, Net Present Value (NPV), Expenditures:



Expenditures: Estimated, discounted and totalized **project expenditures** per period (year).

The Systematic Evaluation of Individual R&D Projects

Capital Value, Net Present Value (NPV), Determining:



Net Present Value (NPV):
Σ of all discounted (e. g. 05%/Y) revenues –
Σ of all discounted (e.g. 05%/Y) expenditures + expenditure at the beginning.

Net Present Value (NPV) > 0 : The project is worthwhile under purely financial aspect, if technical success and market success are *sure*!

The Systematic Evaluation of Individual R&D Projects

Number Example for All Discounted Revenues:

Year	Revenues €	Discount Factors with an Interest Rate of 05% per Year	Present Values €
2020	10.000	1: $(1,05)^1$ = 0,9524	9.524
2021	15.000	1: $(1,05)^2$ = 0,9070	13.605
2022	15.000.000	1: $(1,05)^3$ = 0,8638	12.957.000
2023	32.000.000	1: $(1,05)^4$ = 0,8227	26.326.400

"Projected" to the present day, Σ	**⟶ € 39.306.529**

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The Systematic Evaluation of Individual R&D Projects

Number Example for All Discounted Expenditures:

Year	Expenditures €	Discount Factors with an Interest Rate of 05% per Year	Present Values €
2020	2.400.000	$1: (1,05)^1$ = 0,9524	2.285.760
2021	9.700.000	$1: (1,05)^2$ = 0,9070	8.797.900
2022	600.000	$1: (1,05)^3$ = 0,8638	518.280
2023	20.000	$1: (1,05)^4$ = 0,8227	16.454

"Projected" to the present day, Σ → € 11.618.394

Net Present Value; Numerical Example for the Calculation:

Σ Discounted (5%) Revenues	39.306.529 €
− Expenditure at the beginning	− 170.000 €
− Σ Discounted (5%) Expenditures	− 11.618.394 €
Net Present Value, NPV (Today´s "Future Balance") →	**27.518.135 €**

The Systematic Evaluation of Individual R&D Projects

Leverage Effect of the Interest Rate on the Resulting NPV

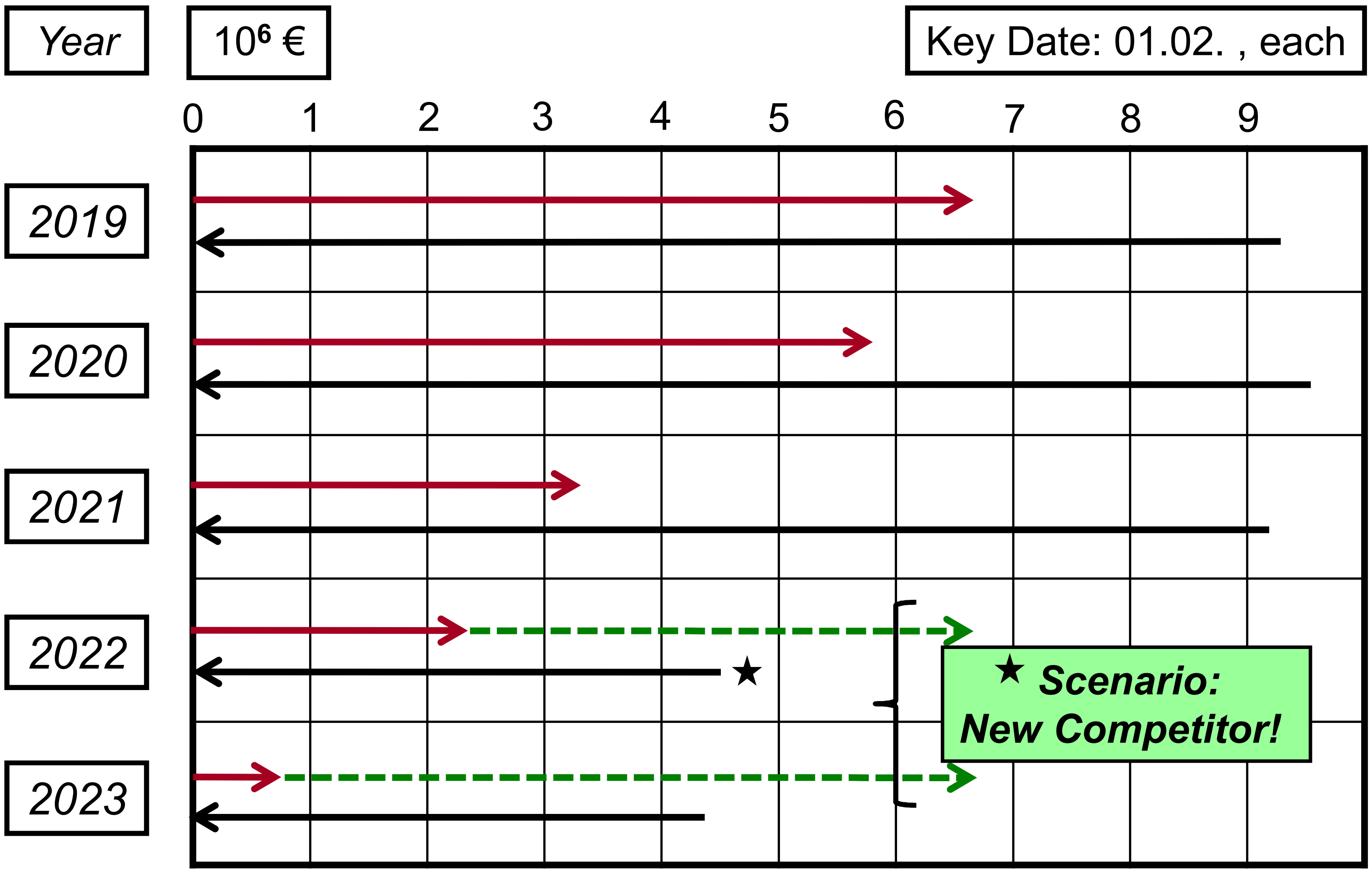
Years	Σ Present Values Revenues €	Σ Present Values Expenditures €	Interest Rates	NPV*
2020 ↓ 2023	43.720.322	12.260.456	**02%**	**31.289.866 €**
2020 ↓ 2023	39.306.529	11.618.394	**05%**	**27.518.135 €**
2020 ↓ 2023	33.146.987	10.662.360	**10%**	**22.314.627 €**

*Assumption: Constant Expenditure at the Beginning of 170.000 €!

Capital Value, Net Present Value, "Sunk Cost-Principle":

(→ : Σ Future Expenses)

(← : Σ Future Revenues)   (- - - -> : "Sunk Costs")



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The Systematic Evaluation of Individual R&D Projects

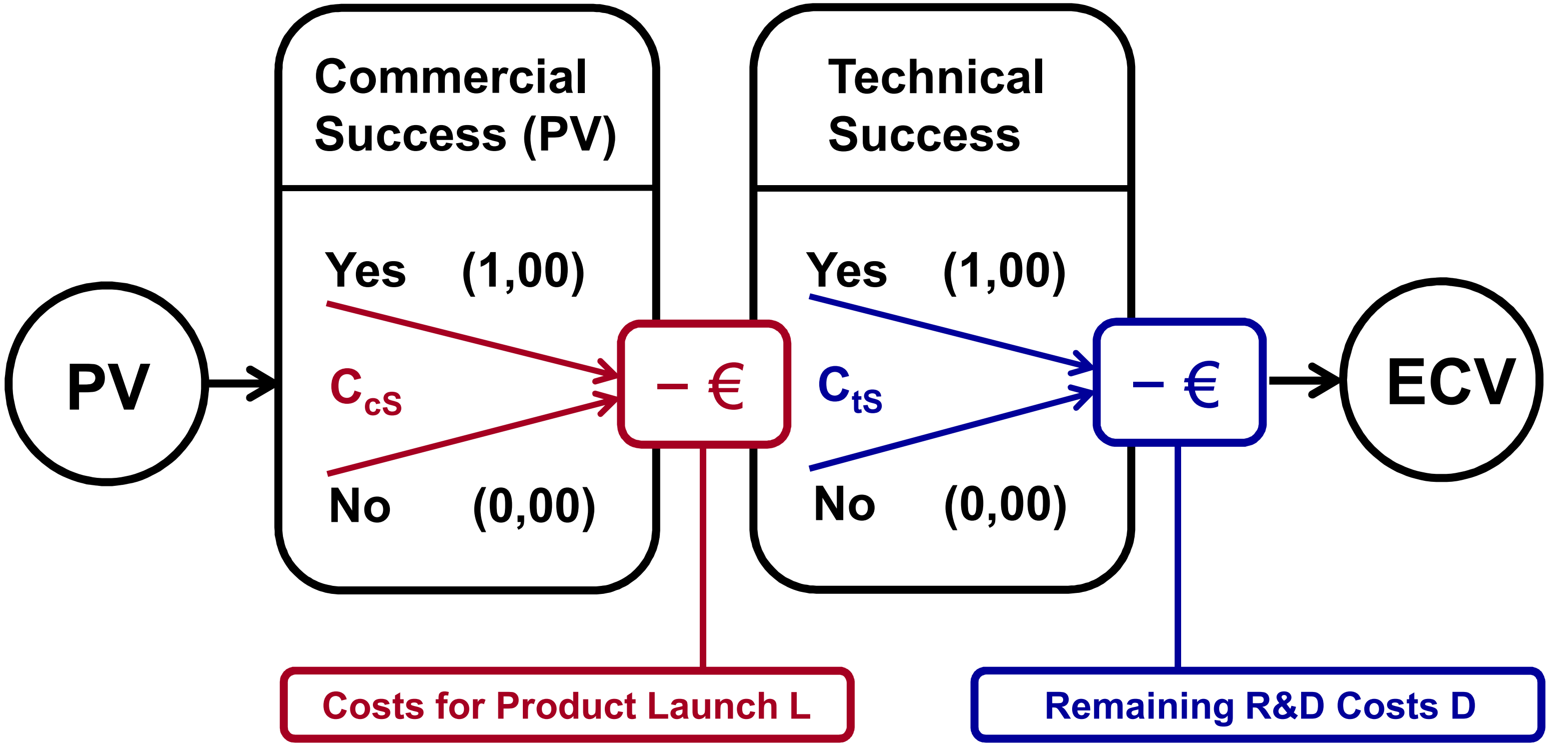
Expected Commercial Value (ECV) for an R&D Project:

$$\longrightarrow \quad ECV = \left[(PV \times C_{cS} - L) \times C_{tS} \right] - D$$

PV	Present Value: Σ of Future, Discounted *Revenues (Cash-inflow),* Cash Value.
C_{cS}	Probability of Commercial Success (0 – 1).
L	Costs for Product Launch and Commercialization.
C_{tS}	Probability of Technical Success (0 – 1).
D	(Remaining) Research and Development Costs.

Expected Commercial Value (ECV) for an R&D Project:

The ECV is the in relation to economic and technical success probability-weighted present value PV(Σ of future discounted revenues). The remaining product launch and development costs, which are independent from those probabilities, have to be subtracted.

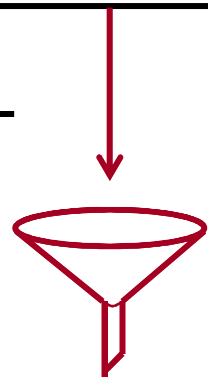


The Systematic Evaluation of Individual R&D Projects

Innovation Process, "Selection Funnel", Effectivity:

≈ 175	Ideas
	↓
≈ 035	R&D Projects
	↓
≈ 015	Products
	↓
≈ 003	Market Launches
	↓
≈ 001	Market Success

Change!	Focus!	Speed!



Estimates from the chemical and pharmaceutical industries (including small and medium-sized companies).

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Example P1

Project Evaluation: Net Present Value (NPV) and Expected Commercial Value (ECV).

Project

"Highly Elastic Clear Coats for the OEM Automotive Sector".

Capital Value, Net Present Value (NPV)

Estimated Revenues (From 01.01.2020) in the R&D Project "Highly Elastic Clear Coats…"

Year	Revenues €	Discount Factors with an Interest Rate of 05% per Year	Present Values €
2020	18.000	$1:(1{,}05)^1$ $= 0{,}9524$	17.143
2021	18.000	$1:(1{,}05)^2$ $= 0{,}9070$	16.326
2022	13.000.000	$1:(1{,}05)^3$ $= 0{,}8638$	11.229.400
2023	24.000.000*)	$1:(1{,}05)^4$ $= 0{,}8227$	19.744.800

*) Assumption: Sales Volume/Year ≈ 1.900 t of paint with an O.R. of € 12.63 per kg. Total O.R. ≈ € 24 million/year.

Σ (€): 31.007.669

Capital Value, Net Present Value (NPV)

Estimated Expenditures (From 01.01.2020) in the R&D Project "Highly Elastic Clear Coats…"

Year	Expenditures €	Dicount Factors with an Interest Rate of 05% per Year	Present Values €
2020	6.495.000	$1 : (1{,}05)^1 = 0{,}9524$	6.185.838
2021	9.167.000	$1 : (1{,}05)^2 = 0{,}9070$	8.314.469
2022	4.120.000	$1 : (1{,}05)^3 = 0{,}8638$	3.558.856
2023	18.000	$1 : (1{,}05)^4 = 0{,}8227$	14.809

Expenditure at the Beginning: 265.000 € (E – Painting Robot)

Σ (€): 18.073.972

Capital Value, Net Present Value (NPV at 1.01.2020)

Numerical Example for the R&D Project "Highly Elastic Clear Coats for the OEM…"

Σ Discounted (5%) Revenues	31.007.699 €
– Expenditure at the beginning (Painting Robot)	– 265.000 €
– Σ Discounted (5%) Expenditures	– 18.073.972 €
Net Present Value, NPV (Today´s "Future Balance") →	**12.688.697 €**

Present Value (PV) for ECV-Calculation

Σ of the Planned Revenues (From 01.01.*2021*) in the R&D Project "Highly Elastic Clear Coats…"

Year	Revenues €	Discount Factors with an Intertest Rate of 05% per Year	Present Values €
2021	18.000	$1: (1{,}05)^1$ = 0,9524	17.143
2022	13.000.000	$1: (1{,}05)^2$ = 0,9070	11.791.000
2023	24.000.000*)	$1: (1{,}05)^3$ = 0,8638	20.731.200

*) Assumption: Sales Volume/Year ≈ 1,900 t of paint with an O.R. of € 12.63 per kg. Total O.R. ≈ € 24 million/year.

Σ (€): 32.539.343

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Expected Commercial Value (ECV) on 01.01.2021

R&D Project "Highly Elastic Clear Coats for the OEM..."

$$\longrightarrow \quad ECV = \left[(PV \times C_{cs} - L) \times C_{ts} \right] - D$$

PV	Present Value: Σ of Future, Discounted *Revenues (Cash-inflow),* Cash Value.	32.539.343 €
C_{cs}	Probability of Commercial Success (0 – 1).	**0,75**
L	Costs for Product Launch and Commercialization.	210.000 €
C_{ts}	Probability of Technical Success (0 – 1).	**0,80**
D	(Remaining) Research and Development Costs.	10.680.000€

ECV = [(32.539.343 € x **0,75** – 210.000 €) x **0.80**]

– 10.680.000 € **=** $\boxed{\textbf{8.675.606 €}}$

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The Subject Matter

- Innovations: Characteristics, Measures for its Promotion, Process Variants.
- Three Examples for Innovation Projects (Chemistry and Technology):
  1. Highly Elastic Clear Coats for the OEM Automotive Sector.
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- Project Manager (m/f/d): Tasks, Leadership Functions and Personality Profile.
- The Systematic Evaluation of Individual R&D Projects.
- **R&D Strategy: The Planning of a Project Portfolio.**

R&D Project Management in the Chemical Industry

Subject Matter →

R&D Strategy:
The Planning of a Project Portfolio.

R&D Project Portfolio – History of its Emergence:

1960 – 1969	→	Hardly R&D projects: Research and development based on the "Principle of Hope".
1970 – 1979	→	Selection and management of individual R&D projects with standard methods.
1980 – 1994	→	Portfolio of attractive R&D projects to hedge individual business areas.
1995 – 2004	→	R&D project portfolio as a strategic and *corporate* entrepreneurial tool.
2005 – today	→	StageGate®- processes for the *continuous steering* of the current R&D project portfolio.

R&D Project Portfolio Planning; Effectiveness – Efficiency.

Effectiveness:

Selection of the right projects/goals.

→ **"Doing the right things"**

Efficiency:

Choosing the right working method.

→ "Doing the things right"

→

Σ: Efficacy

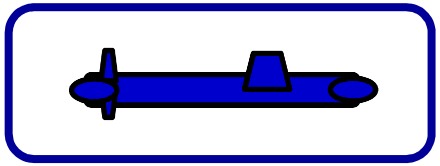
Strategic Leverage!

Indispensable: The Setting of Priorities!

"Setting priorities also means deciding what should *not* be done!"

For this, all opportunities and risks in market, chemistry and technology regularly have to be assessed!

(If this does ***not*** happen →



Numerous uncontrolled **"Submarine Projects"!**

R&D Strategy: The Planning of a Project Portfolio

Necessary:
A smooth, trans-functional and cross-sectoral cooperation in the own company.

!

R&D strategies reflect the **"conscience"** of a company. They have a transdisciplinary, company-wide character, and they are indispensable!

The corresponding strategic planning requires the cooperative **interaction** of technical, sales-related and financial resources.

R&D Strategy: The Planning of a Project Portfolio

Necessary:
A smooth, trans-functional and cross-sectoral cooperation in the own company.

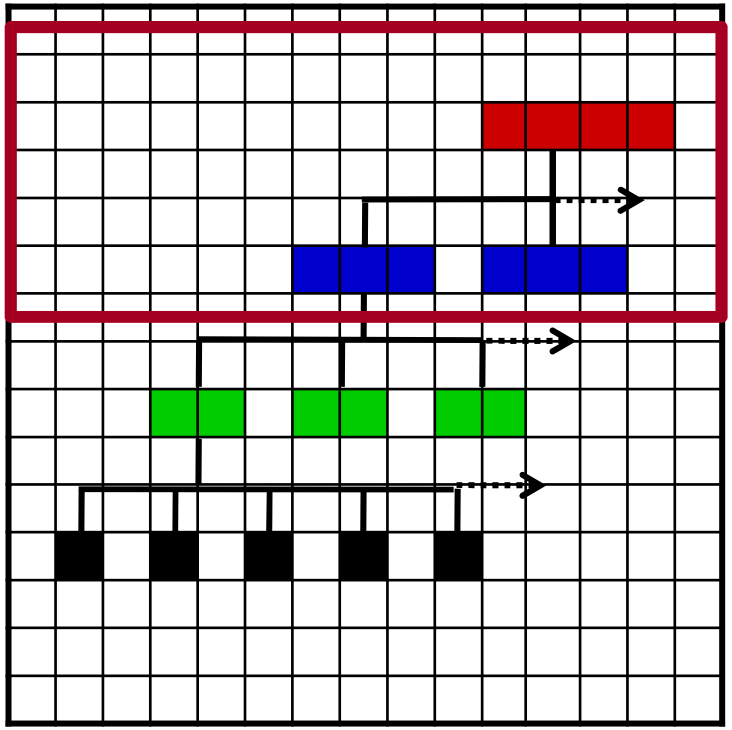
!

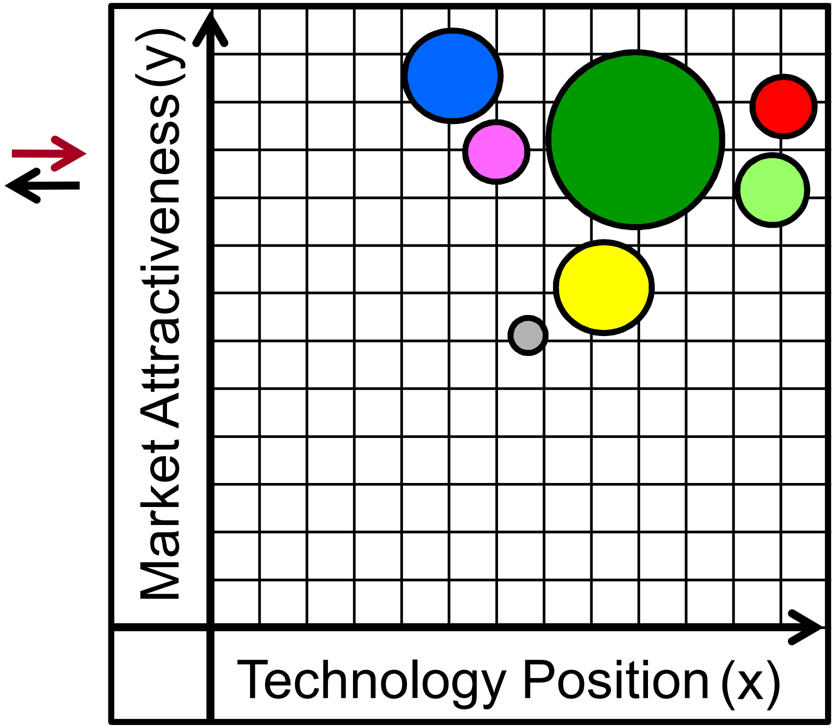
Unfortunately, some people responsible for planning research and development projects cannot say **"No!"**.

This causes, that their companies will frittering away their precious R&D resources and can not gain a strong technology position anywhere.

R&D Strategy: The Planning of a Project Portfolio

Innovation Driver "Project-Tied Economy":





- **Project Release-Field**
- Board Members
- GBU-/Division-Heads
- T.S.C.-Members

- **R&D Strategy Matrix**
- Technology Matrix
- Market Matrix
- R&D Budget (€)

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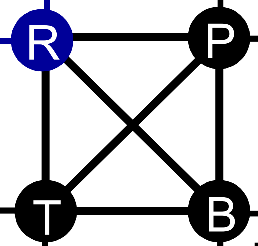
Types of Strategic Portfolio Planning and Steering in the Chemical Industry and their Full Cross-Linking (Simplex):

R&D Project Portfolio

R&D Project-Related Success Factors:
Assessment of the current situation and the future potential in terms of technology and market, conformity with the corporate strategy.

Product Portfolio

Supply-related Success Factors:
Future products, product groups, product substitutions, product deletions, noticeable trends (Lifestyle-changes).



K_4 - Graph $\begin{bmatrix}4\\2\end{bmatrix}$

Technology Portfolio

Technical-Logistical Success Factors:

Production process, plant design, factory-network, transport, warehousing, safety, environmental protection measures.

Business Portfolio

Entrepreneurial Success Factors:

Business strategy, current and future markets, market shares, market growth, complete value chains.

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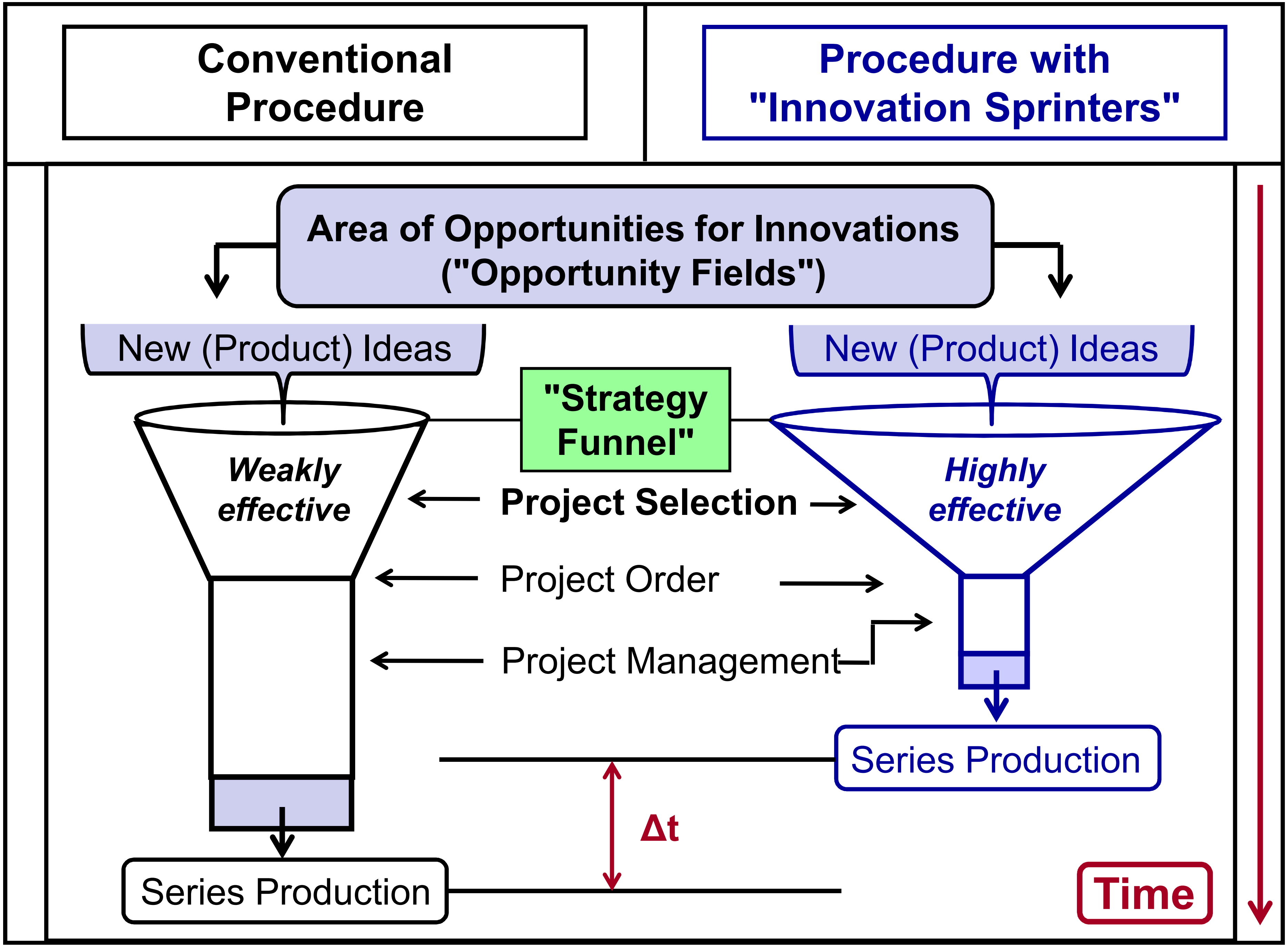

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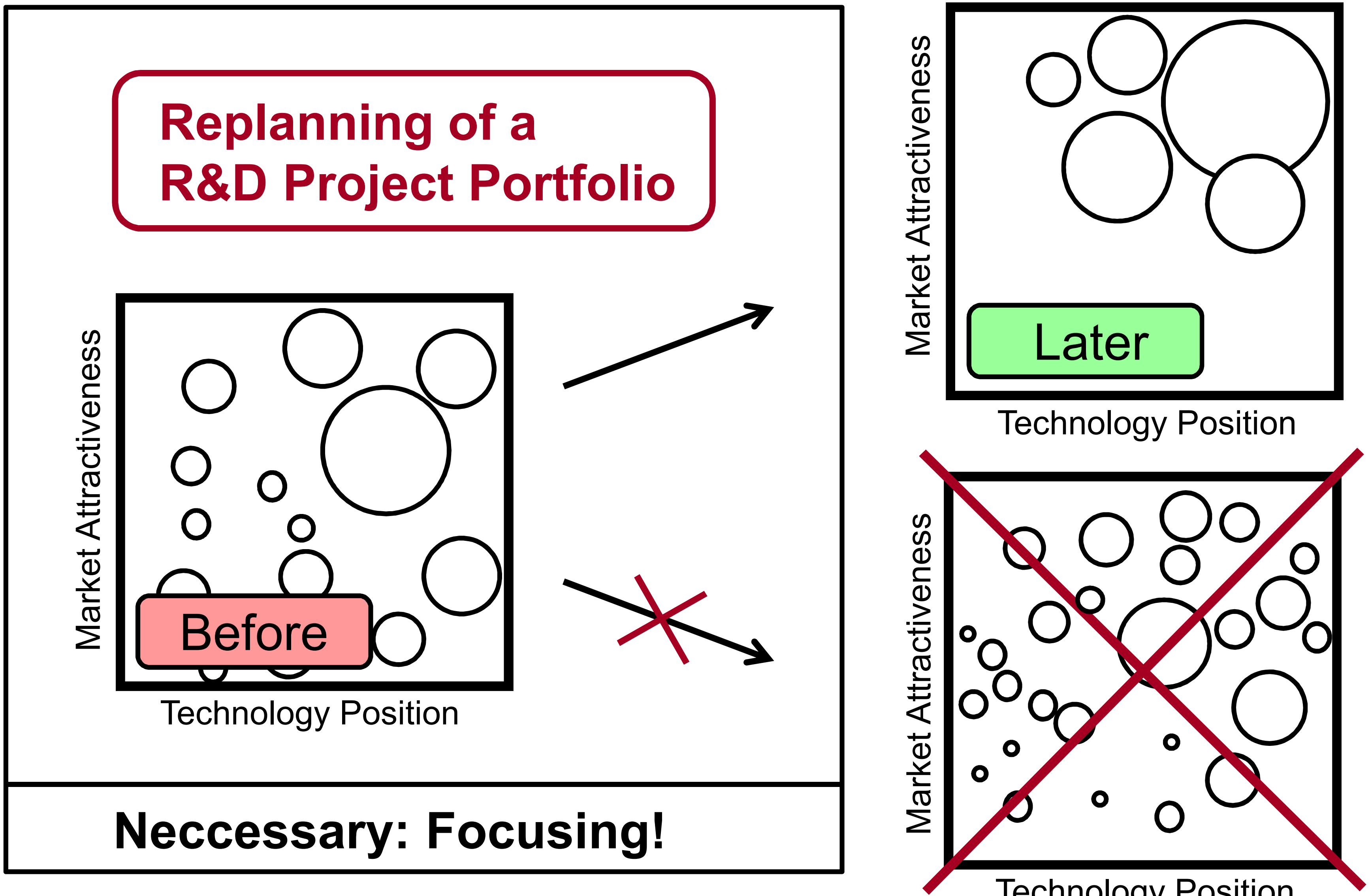
R&D Project Portfolio Planning: **Technology Market Matrix.**



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R&D Strategy: The Planning of a Project Portfolio

The Technology Market Matrix:

An **effective tool** for the targeted structuring **of the R&D strategy planning** between research / development on the one hand and the company management together with the operational business divisions on the other.

Examples of operational divisions in the chemical and pharmaceutical industries (Global Business Divisions):

Pharmaceuticals, Consumer Health, Vaccines, Intermediates, Fine Chemicals, Performance Chemicals, Petrochemicals, Construction Chemicals, Catalysts, Dispersions, Pigments, Coatings, Agricultural Products, Polycarbonates, Styrenics, Polyurethanes, Polysiloxanes, Oil&Gas, etc.

R&D Strategy: The Planning of a Project Portfolio

The Technology Matrix; Two Coordinate Axes (x/y):

The **technology matrix** provides information about the status and development potential of the own technologies.

(Own) Technology	Sum of all (own) technical and scientific methods and of all functional operational equipment.
Technology Position $(0 \leq x \leq 100)$	**State of the company's technology in (external) comparison to that of the competition.**
Technology Potential $(0 \leq y \leq 100)$	**Development possibilities of the own technology from internal company`s view.**

R&D Strategy: The Planning of a Project Portfolio

The Technology Matrix, Content; Position (x), Potential (y):

Technology Position:

Current state of one`s own technology compared to the technologies of the worldwide (or also regional) relevant competitors.

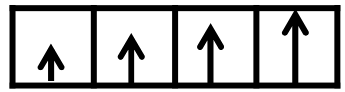
In Relation to the Competition!

Position

Technology Potential:

Development potential of one`s own current technologies. The identified potentials should be realizable and commercially usable.

Without Reference to the Competition!



Potential

R&D Strategy: The Planning of a Project Portfolio

→ Technology Position:

Criteria

- R&D Competence
- Procedures
- Product Performances
- Raw Materials/Intermediates
- Facilities/Infrastructure/Verbund
- Patents/Licenses
- Costs

R&D Strategy: The Planning of a Project Portfolio

→ Technology Position:

Criteria	**Factors**
R&D Competence	Current ability to find new, competitive products, processes and applications. Present competence/training of scientific and technical personnel. Use of available know-how synergies. Current internal and external knowledge transfer. Todays existing research collaborations.
Procedures	Present competitiveness of procedures: Yields, chemical conversions, quality, costs, ecological/toxicological safety. Transferability of the procedure to other products. Current state of the art.
Product Performances	Competitiveness of one`s own current products. Purity of these products. Present physical and biological properties of the new substances.
Raw materials/ Intermediates	Current availability of raw materials at acceptable prices, own raw material supply, number and reliability of external supply sources.
Facilities/Infrastructure/ Verbund	Type and condition of production equipment, apparatuses. Reliable energy supply, functioning disposal facilities required for production.
Patents/Licenses	Intellectual property rights for the own research results. Present existence of own key patents and prohibition rights of third parties. Availability of competent and committed cooperation partners.
Costs	Current manufacturing costs, investment costs, variable costs and fixed costs, economies of scale. Company-owned synergies.

R&D Strategy: The Planning of a Project Portfolio

→ **Technology Potential:**

Criteria

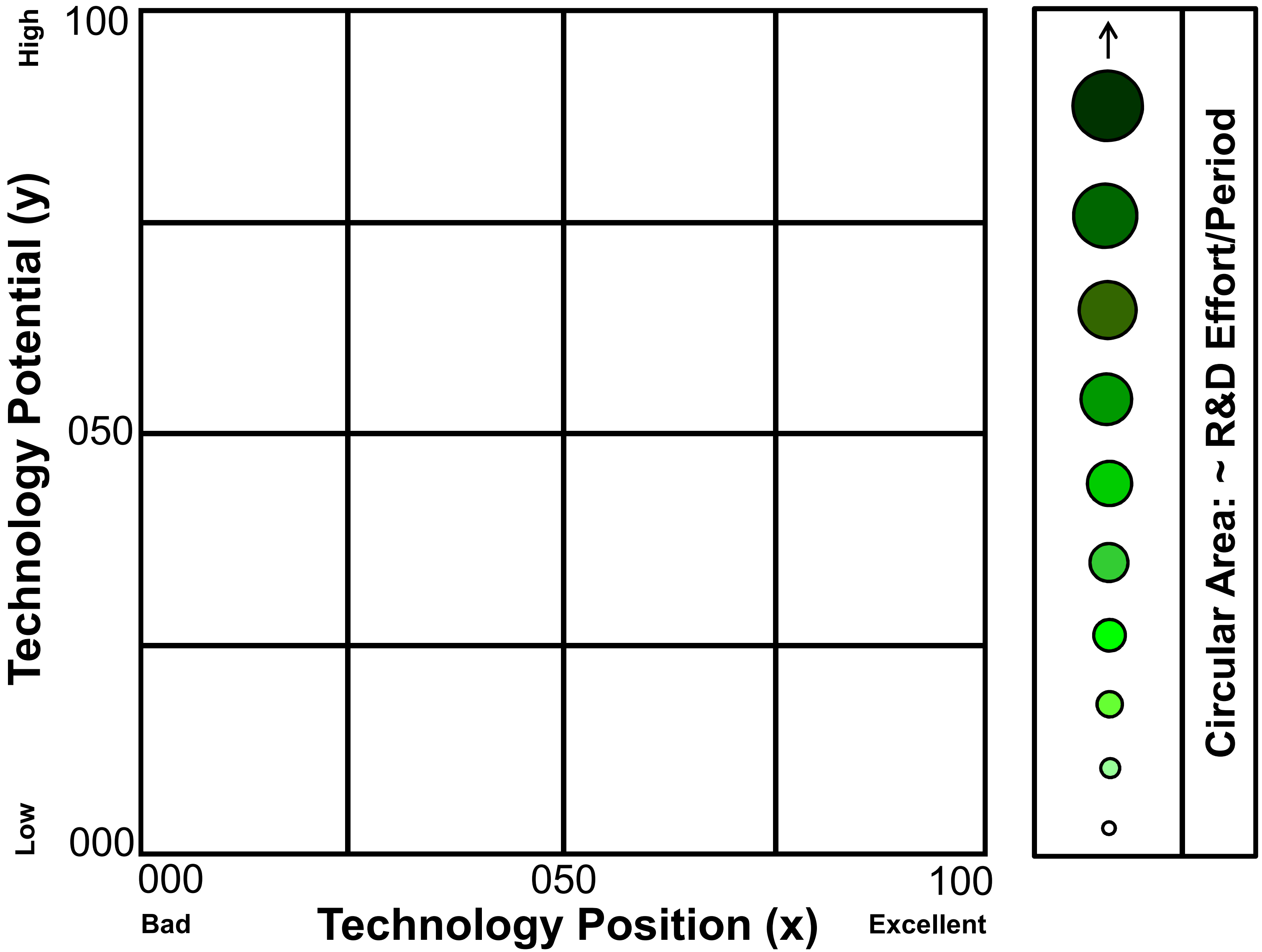
- Innovation Potential through R&D
- Procedures
- Product Performances
- Raw Materials/Intermediates
- Facilities/Infrastructure/Verbund
- Patents/Licenses
- Costs

R&D Strategy: The Planning of a Project Portfolio

→ Technology Potential:

Criteria	Factors
Innovation potential through R&D	Probability to develop fundamentally new products and processes in future. Existing starting points. Long-term expertise of the staff, prospective availa-bility of know-how and synergies. Envisaged future research collaborations.
Procedures	Possibility for improvement of existing, own procedures concerning yield, substance turnover, product quality, costs, (eco) toxicological problems.
Product performances	Opportunities for the improvement of future products/product ranges. Possible and feasible physical, technical or biological property profile.
Raw materials/ Intermediates	Improvement of the availability of raw materials at acceptable prices. Own, long term future supply of raw materials. Number and reliability of external sources of supply.
Facilities/Infrastructure/ Verbund	Approaches for improving the type and / or condition of equipment required for production, better equipment. Future secure energy supply. Long-term functioning modern disposal facilities.
Patents/Licenses	Potential for improvement of own industrial property rights situation. Own key patents, potential, attractive cooperation partners.
Costs	Opportunities to reduce manufacturing costs, investment costs, variable and fixed costs. Possibilities for "Economy of Scale". Company-owned, future synergies.

R&D Project Portfolio, Planning → **Technology Matrix:**



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R&D Strategy: The Planning of a Project Portfolio

The Market Matrix; Two Coordinate Axes (x/y):

The **market portfolio** provides information about one's own position in the market and the future appeal to the business.

(Own) Market	Fields of the own business activities in the interaction of supply and demand.
Market Position $(0 \leq x \leq 100)$	**Own current position in the market, with regard to a product or a product group.**
Market Attractiveness $(0 \leq y \leq 100)$	**Future attractiveness of the market (within 10 years) from the company's own point of view.**

R&D Strategy: The Planning of a Project Portfolio

The Market Matrix, Content; Position (x), Attractiveness (y):

Market Position:

Current position of the own company in relation to the positions of the worldwide (possibly regional) important competitors.

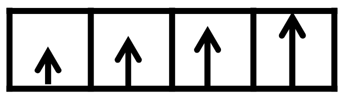
In Relation to the Competition!

Position

Market Attractiveness:

Future attractiveness of the market from the perspective of one's own company (perspective: 10 years) in relation to other "own" markets.

Without Reference to the Competition!



Potential

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R&D Strategy: The Planning of a Project Portfolio

→ **Market Position:**

Criteria

- Market Share
- Internal Consumption
- Earnings Position
- Logistics
- Marketing Expertise
- Product Quality
- Customer Structure
- Product Range

R&D-Strategy: The Planning of a Project Portfolio

→ Market Position:

Criteria	Factors
Market Share	Today's shares of the worldwide market volume and of the regional market.
Internal Consumption	Current opportunity to use resulting (intermediate) products in-house and integrate them into the own value chains.
Earnings Position	Present revenue after deducting all costs per ton sold / kilogram of product sold.
Logistics	Current situation with regard to smooth transport and delivery of the products according to the customer's request ("just in time").
Marketing Expertise	The own ability to successfully position current products in the market through service. Efficient technical service on site. Experience and flexibility of the current sales team.
Product Quality	Properties of today's product meet / exceed customer requirements. Quality constancy, no complaints.
Customer Structure	Current number, size, locations and (buy) behavior of key customers. Their current buyer power and credit rating.
Product Range	Today's product variety with regard to the current market needs. Complete "product range offers". Current buying habits of customers.

R&D Strategy: The Planning of a Project Portfolio

→ Market Attractiveness:

Criteria

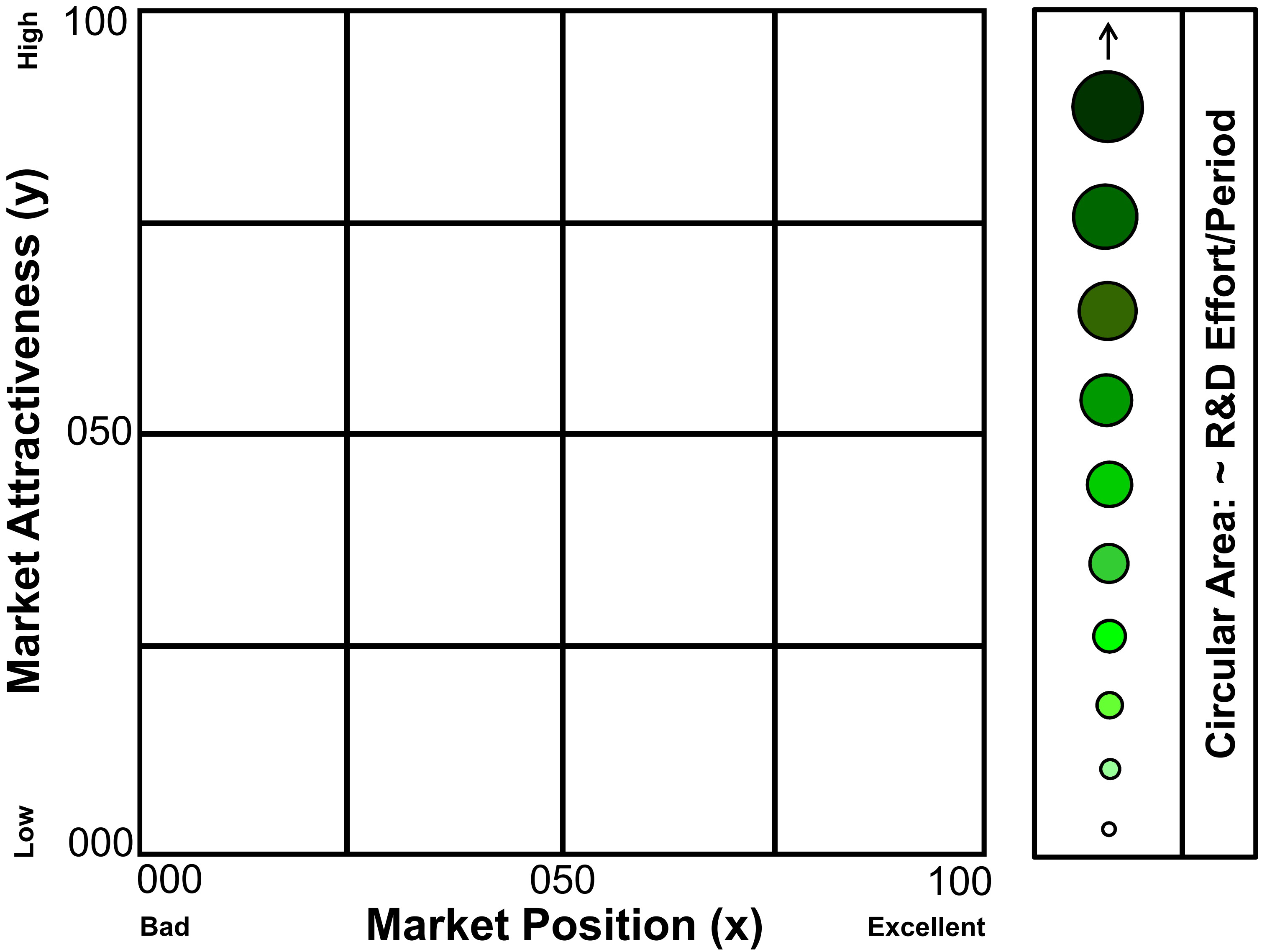
- Market Growth
- Market Volume
- Displacement/Substitution
- Market Access Barriers
- Earnings Prospects
- Supplier Structure
- Customer Structure
- Environmental Situation

R&D-Strategy: The Planning of a Project Portfolio

→ Market Attractiveness:

Criteria	**Factors**
Market Growth	Expected average annual growth of the market in the next 10 years. New fields of application. Future law changes.
Market Volume	Expected volume-related and value adding-related market size in about 10 years.
Displacement/ Substitution	Future replacement of competitor`s products with own products or the substitution of own products. Likely speeds and the foreseeable extent of predatory competition and product substitution.
Market Access Barriers	Upcoming legal regulations. Need for big investments. Regulatory restrictions. Possible technical hurdles.
Earnings Prospects	Expected future earnings and return in the own company (BE, Gross Yield).
Supplier Structure	Number, size, locations and future behavior of competitors, intensity of competition. Later mergers and concentration processes.
Customer Structure	Foreseeable number, size, locations and purchasing behavior of the customers. Their future market force. Later concentration processes. Probability of centralization of customer`s purchasing.
Environmental Situation	Later influences of the market for reasons of environmental protection. Upcoming legal regulations, changes of acceptance in the population.

R&D Project Portfolio, Planning → **Market Matrix:**



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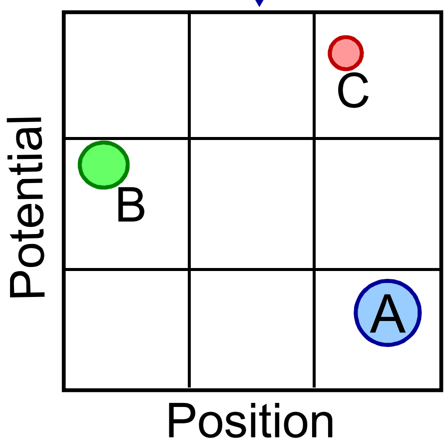
R&D Strategy: The Planning of a Project Portfolio

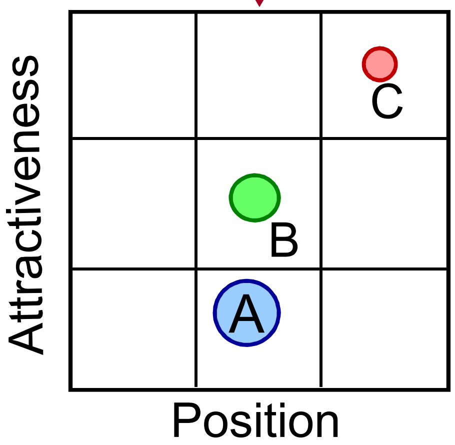
Three "Dialog Boxes" as Planning Basis:

Innovation strategy as a function of technology matrix, market matrix and product-specific life cycle analyses.

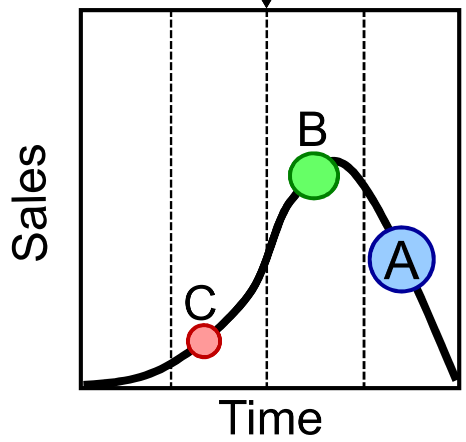
Technology Matrix



Market Matrix



Life Cycle Position



Innovation Successes

First-class chemical and technical skills; Highly qualified staff; Top equipment: laboratory, technical center and production; Coordinated R & D project portfolio. Competent pilot customers with "market impact".

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Elaboration of a Technology Market Matrix:

Step 1:
Project-specific **weighting of the individual criteria.**

Each individual criterion receives a project-dependent weighting.

The scale ranges from 0 (unimportant) to 5 (very important).

Through a rating with 0, the criterion in question is cancelled
and the remaining criteria become more important.

Elaboration of a Technology Market Matrix:

Step 2:
Project-specific **assessment** based on all **individual criteria.**

Each project is assessed on the basis of all relevant individual criteria. The scale for these ranges from 1 (very bad) to 5 (very good).

The evaluation takes place in a team involving experts from research, development, production, marketing, sales, environmental protection/safety.

R&D Strategy: The Planning of a Project Portfolio

Elaboration of a Technology Market Matrix:

Step 3:
Project-specific **standardization of the sum of all ratings.**

The standardization is based on the best possible assessment for each individual criterion (5 ⟶ very good).

The project-specific scaling is done by dividing the highest possible value 100 by the sum of all values from (weighting X 5 (assessment)) ⟶ Normalization Factor.

R&D Project, Weighting of the Individual Criteria

Example

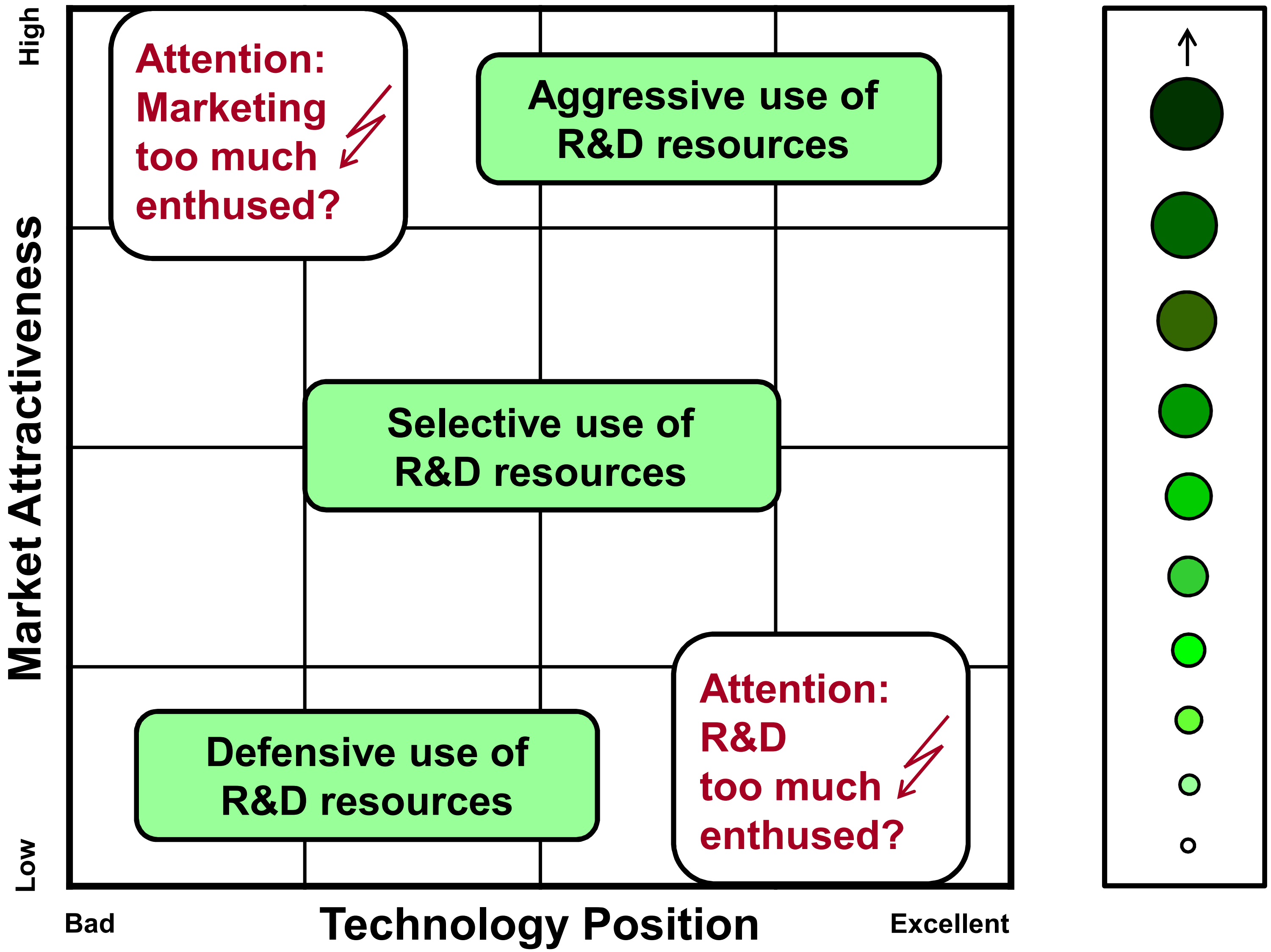
Technology Position, **Normalization → Maximum Value: 100.**

Criterion	Weighting	Assessment (Maximum!)	Weighting x Assessment
R&D Competence	05	05	25
Procedures	04	05	20
Product Performance	02	05	10
Raw Materials/Intermediates	01	05	05
Facilities/Infrastructure	02	05	10
Patents/Licenses	04	05	20
Costs	03	05	15
Total	Σ 21		**Σ 105**

Scaling Factor: 100/Σ Weighting x Assessment	**100/105 ≈ 0,95**

R&D Strategy: The Planning of a Project Portfolio

Appropriate use of Funds through a Valid Positioning:



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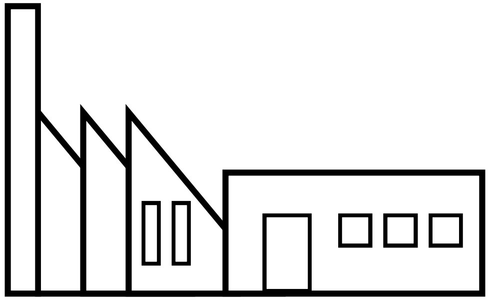
Example P1

Portfolio Planning:
Positioning of a R&D Project.

Project	**"Highly Elastic Clear Coats for the OEM Automotive Sector".**

R&D Project "Highly Elastic Clear Coats for the OEM…"



The Coatings and Chemical Company "[…GmbH 1]":

Larger, medium-sized company: 1270 employees worldwide, including 25 chemists, 37 engineers (FH), 19 engineers (TU).

Own research and development, own production facilities for synthetic polyacrylates and paints made from these. Active for 15 years in the field of "clear coats for the OEM finishing of automobiles".

Chemical specialty: Production of "tailor-made" OH-polyacrylates.

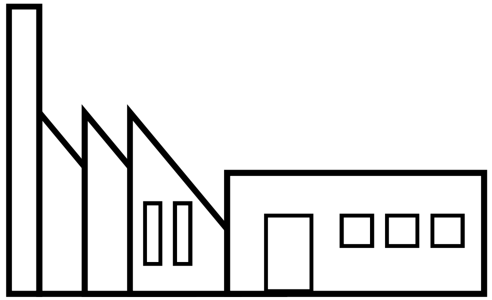
R&D Project "Highly Elastic Clear Coats for the OEM…"

Technology Position, Normalization: Maximum Value 100.

Criterion	**Weighting**	**Assessment (Maximum!)**	**Weighting x Assessment**
R&D Competence	04	05	20
Procedures	02	05	10
Product Performance	05	05	25
Raw materials/Intermediates	03	05	15
Facilities/Infrastructure	02	05	10
Patents/Licenses	04	05	20
Costs	02	05	10
Total	Σ 22		**Σ 110**

Scaling Factor: 100/Σ Weighting x Assessment	**100/110 ≈ 0,91**

R&D Project "Highly Elastic Clear Coats for the OEM…"



Technology Matrix
Framework Conditions

- Dependence on various raw material suppliers, especially those who supply diisocyanates and oligools for the production of HBC crosslinkers.
- Currently, personnel and maintenance-intensive batch plants are used. Plan: Construction of a continuously operating new plant in Slovakia (EU).
- High wage and energy costs at today's production site. Plan: Relocation of the entire production to Eastern Europe in about 3 years.

- Owner of key patents with long remaining terms.
- Future collaborations with leading research institutes in the field of new materials are in an advanced planning process.

R&D Project "Highly Elastic Clear Coats for the OEM…"

Technology Position:

Criterion	Weighting	Assessment	Weighting x Assessment
R&D Competence	04	→ 02	08
Procedures	02	03	06
Product Performance	05	03	15
Raw Materials/Intermediates	03	→ 02	06
Facilities/Infrastructure	02	03	06
Patents/Licenses	04	→ 05	20
Costs	02	→ 02	04
Total	Σ 22		**Σ 65**

Scaling Factor	**100/110 ≈ 0,91**	**65 x 0,91 =**	$\boxed{\textbf{59,15}}$

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R&D Project "Highly Elastic Clear Coats for the OEM…"

Technology Potential:

Criterion	Weighting	Assessment	Weighting x Assessment
Innovation potential, R&D	04	→ 04	16
Procedures	04	03	12
Product performance	03	05	15
Raw materials/Intermediates	03	02	06
Facilities/Infrastructure	02	03	06
Patents/Licenses	03	03	09
Costs	05	→ 04	20
Total	Σ 24		**Σ 84**

Scaling Factor	**100/120 ≈ 0,83**	**84 x 0,83 = $\boxed{69{,}72}$**

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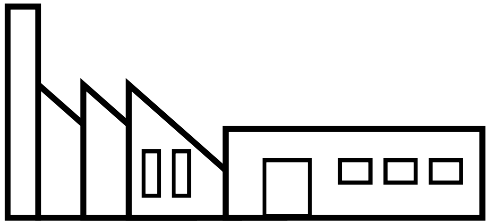
R&D Project "Highly Elastic Clear Coats for the OEM…"



Market Matrix
Framework Conditions

- Market share currently <10% because other, larger polyacrylate manufacturers with "classic", sometimes water-based clearcoats have an oligopoly position in the automotive industry.
- Due to the high degree of specialization in the delivery area of "High-branched Crosslinkers", no further "horizontal synergies” or self-consumptions of "HBCs" as coating agents can be used in the own chemical factories.

- By the use of new reactors, working under inert gas with radially promoting disc stirrers a high purity of HBC`s is ensured. Future quality advantage over the products of competitors.
- Very good earnings prospects due to a rapidly growing market for scratch-resistant automotive coatings.
- All eco-toxicological preconditions and the corresponding environmental protection measures have been implemented for a future, successful marketing.

R&D Project "Highly Elastic Clear Coats for the OEM…"

Market Position:

Criterion	Weighting	Assessment	Weighting x Assessment
Market Share	04	→ 02	08
Internal Consumption	03	→ 01	03
Earnings Position	03	04	12
Logistics	02	04	08
Marketing Expertise	04	03	12
Product Qualität	05	→ 05	25
Customer Structure	04	04	16
Product Range	04	03	12
Total	Σ 27		**Σ 96**

Scaling Factor	100/135 ≈ 0,74	96 x 0,74 =	$\boxed{71,04}$

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R&D Project "Highly Elastic Clear Coats for the OEM…"

Market Attractiveness:

Criterion	Weighting	Assessment	Weighting x Assessment
Market Growth	05	→ 05	25
Market Volume	03	03	09
Displacement/Substitution	02	04	08
Market Access Barriers	04	→ 05	20
Earnings Prospects	05	→ 05	25
Supplier Structure	04	04	16
Customer Structure	03	03	09
Environmental Situation	02	05	10
Total	Σ 28		**Σ 127**

Scaling Factor	**100/140 ≈ 0,71**	**127 x 0,71 =**	**90,17**

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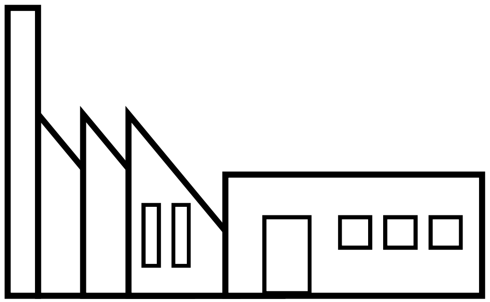
R&D Strategy: The Planning of a Project Portfolio

R&D Project "Highly Elastic Clear Coats for the OEM…"

[…GmbH 1]



Technology Position: **59**

Technology Potential: **70**

Market Position: **71**

Market Attraktiveness: **90**

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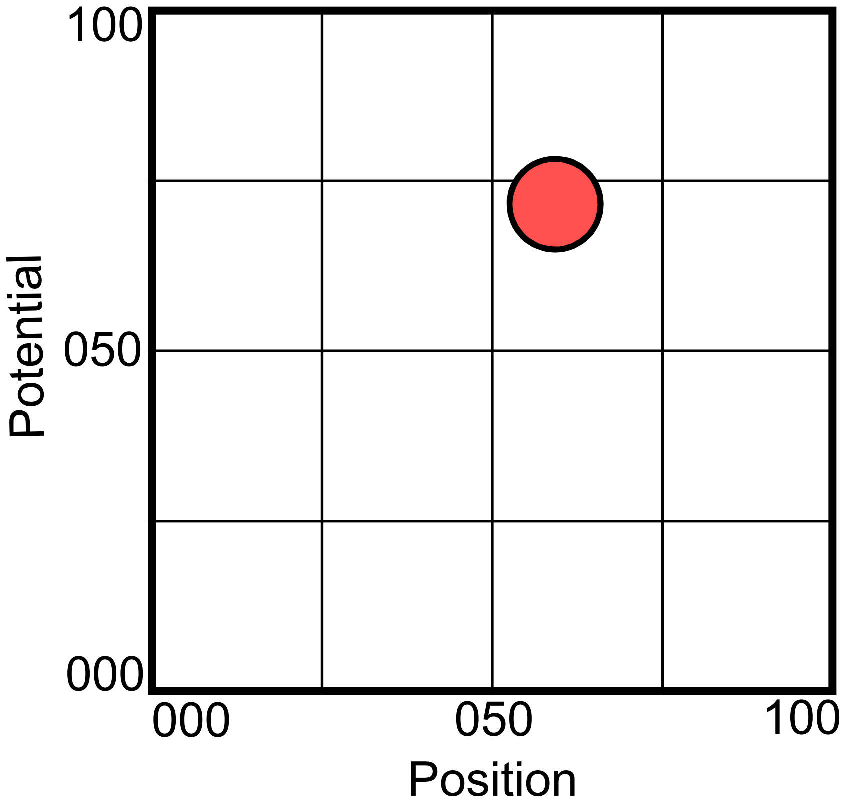
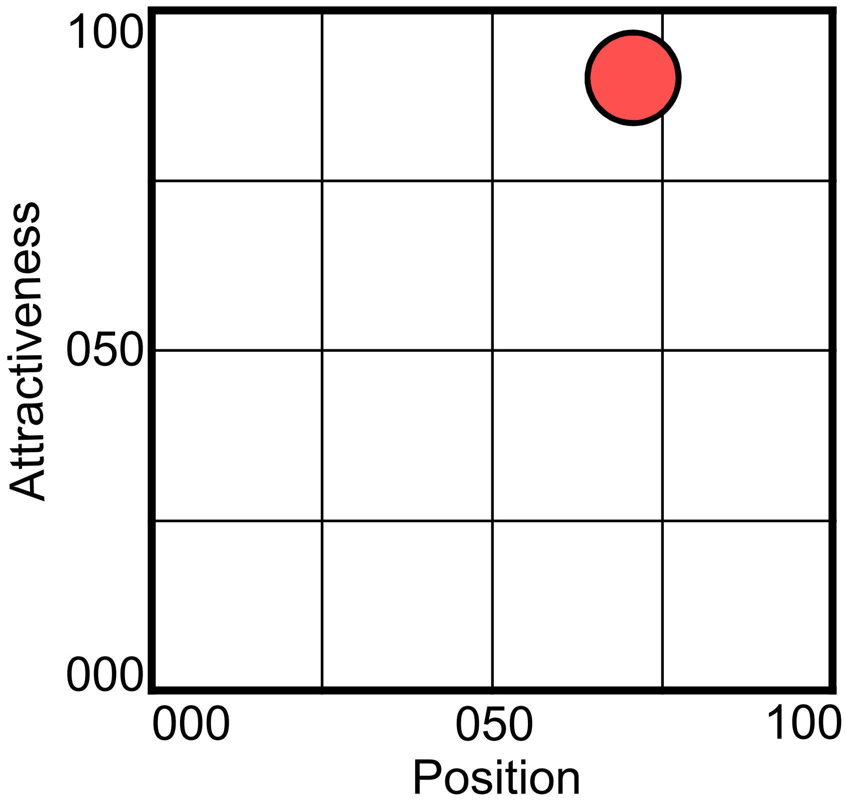
R&D Strategy: The Planning of a Project Portfolio

R&D Project "Highly Elastic Clear Coats…" (●):

Technology Matrix



Market Matrix



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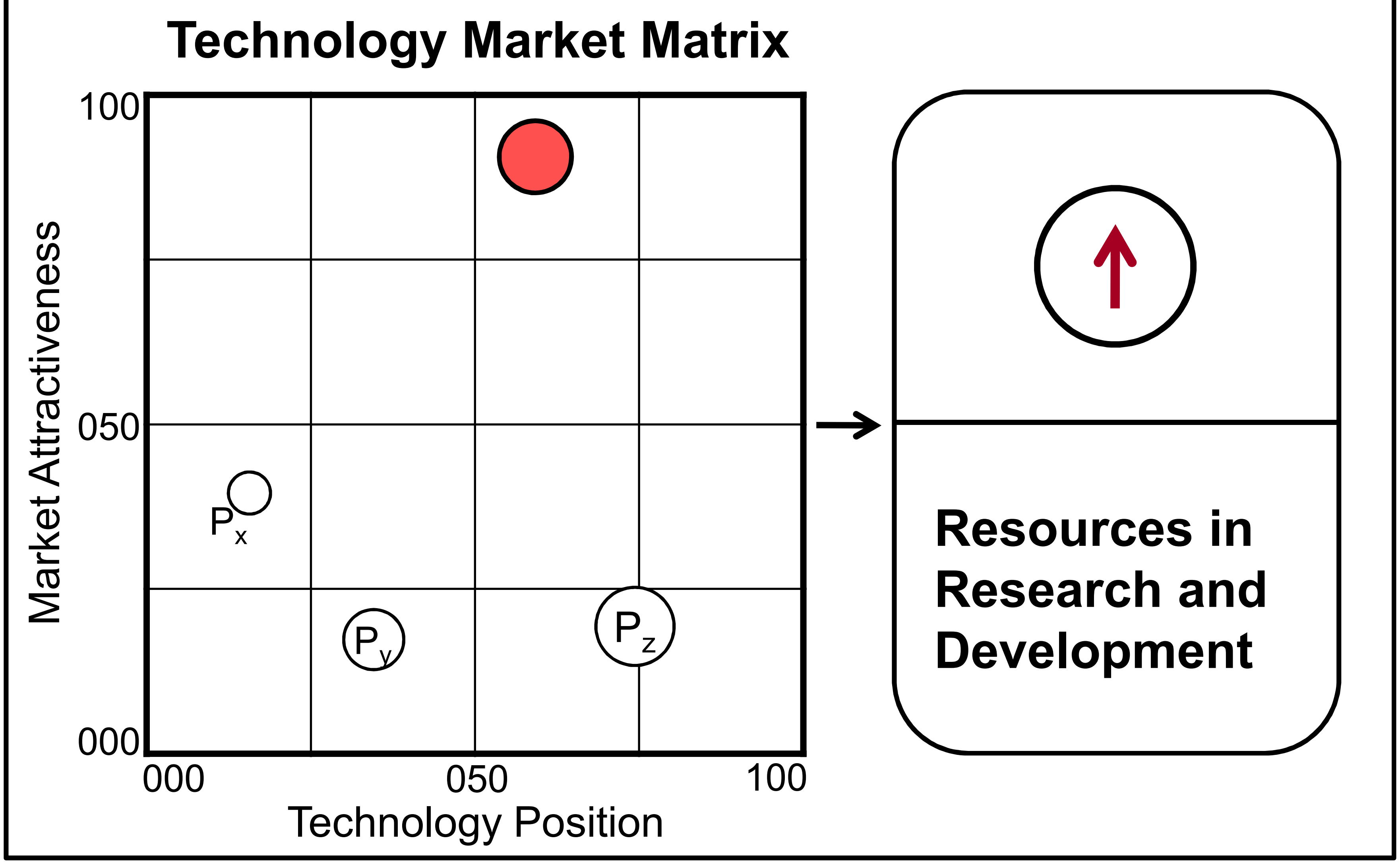
R&D Strategy: The Planning of a Project Portfolio

R&D Project "Highly Elastic Clear Coats…" ( ):



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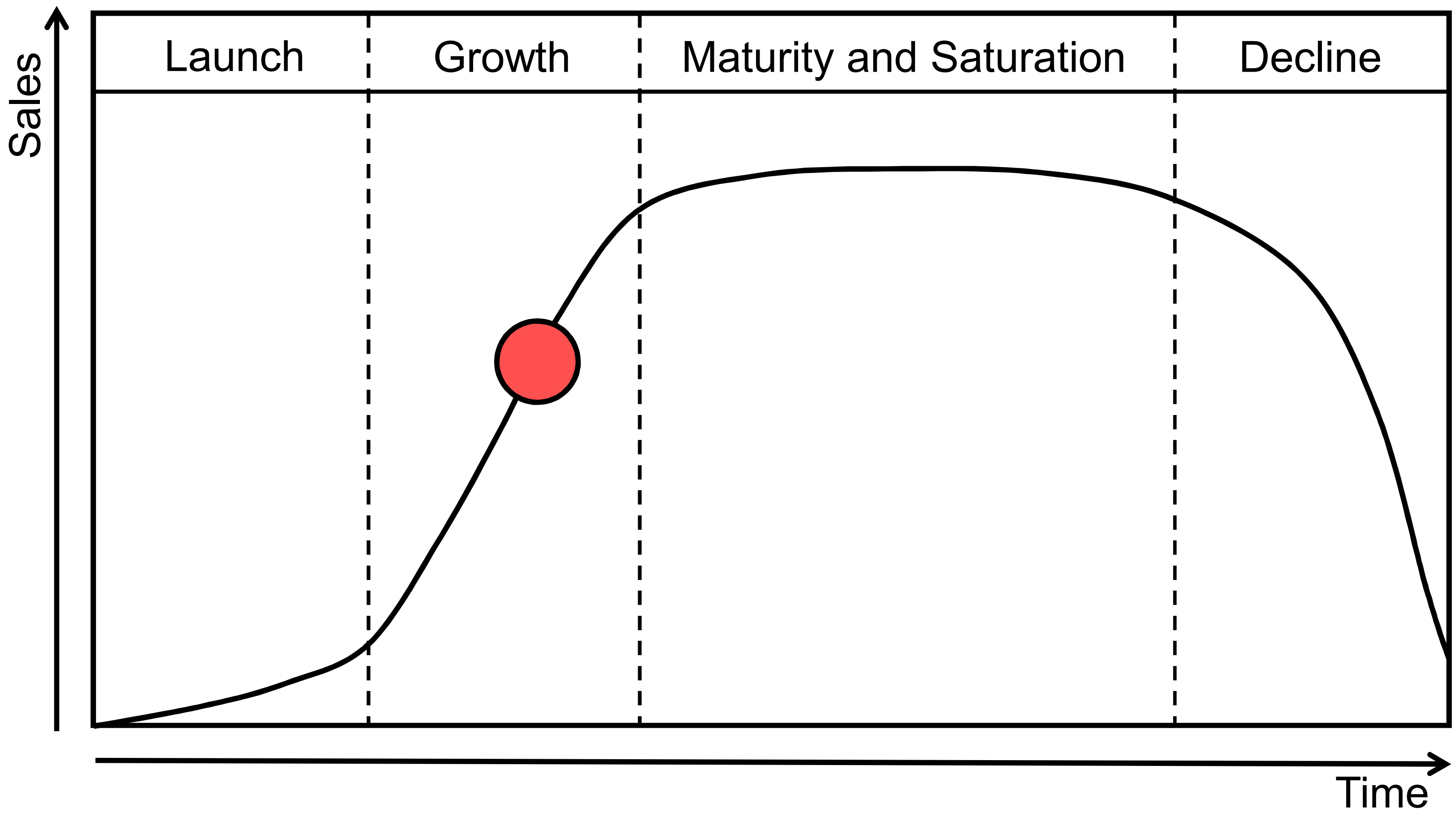
R&D Strategy: The Planning of a Project Portfolio

R&D Project "Highly Elastic Clear Coats…" ( ):

Life Cycle Position



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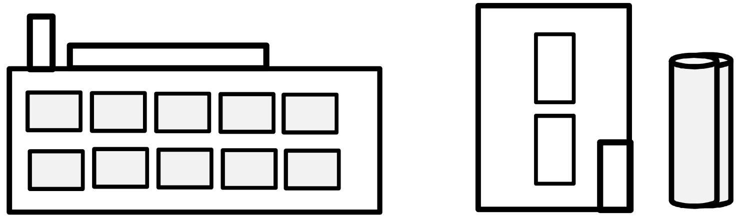
Example P2

Portfolio Planning:
Positioning of a R&D Project.

Project	**"Nitrilase-Catalyzed Synthesis of a Chiral α-Hydroxycarboxylic Acid".**

R&D Project "Nitrilase-Catalyzed Synthesis…"



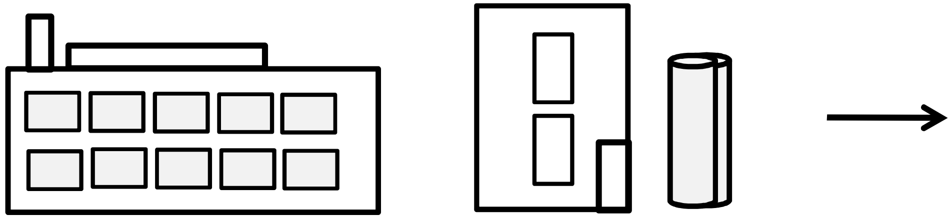
The Biotech-Company "[…GmbH 2]":

Start-up company with 77 employees throughout Europe, including 15 (bio) chemists, 7 microbiologists, 13 engineers (FH), 4 engineers (TU).

Own research and development with attached production and pilot plants. Active for 8 years in R&D, scale-up and the production of ChiPros using "White Biotechnology".

Special products: Enantiomeric pure, optically active carboxylic acids, carboxylic esters and amines as intermediates for new pharmaceutical agents and crop protection products.

R&D Project "Nitrilase-Catalyzed Synthesis…"



Technology Matrix
Framework Conditions

- Medium-term indispensable investments in a continuously operating "Chemostat bioreactor" equipped with modern measuring and control technology, corresponding to the state of the art.
- Uncertainty about the short- and long-term development of the state of science and technology in the case of nitrilases within white biotechnology. Noticeable increase in patent applications by the competition.

- Excellent, consistent product purity thanks to a reliable quality control.
- Free access to the latest biotechnological research results. Very good position for recruiting top biotechnologists or chemists.
- Reliable raw material base through a long-term safe and steady supply of cyanohydrin from 2-methoxy-2-methyl-propanal by the parent company.

R&D Project "Nitrilase-Catalyzed Synthesis…"

Technology Position:

Criterion	**Weighting**	**Assessment**	**Weighting x Assessment**
R&D Competence	05	→ 05	25
Procedures	05	→ 03	15
Product Performance	05	→ 05	25
Raw Materials/Intermediates	03	→ 05	15
Facilities/Infrastructure	04	03	12
Patents/Licenses	05	04	20
Costs	03	05	15
Total	Σ 30		**Σ 127**

Scaling Factor	**100/150 ≈ 0,67**	**127 x 0,67 =**	**85,09**

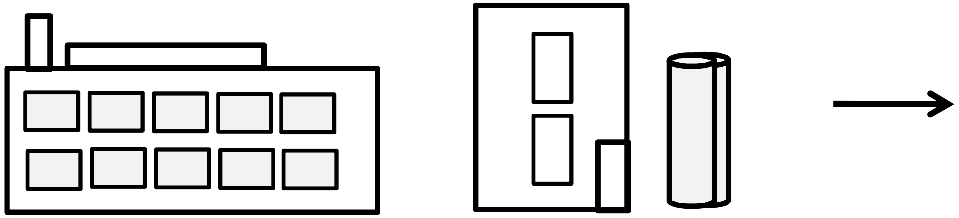
R&D Project "Nitrilase-Catalyzed Synthesis…"

Technology Potential:

Criterion	Weighting	Assessment	Weighting x Assessment
Innovation potential, R&D	04	→ 05	20
Procedures	05	04	20
Product performance	05	→ 05	25
Raw materials/Intermediates	04	→ 04	16
Facilities/Infrastructure	04	05	20
Patents/Licenses	05	→ 02	10
Costs	04	04	16
Total	Σ 31		**Σ 127**

Scaling Factor	**100/155 ≈ 0,65**	**127 x 0,65 =**	**82,55**

R&D Project "Nitrilase-Catalyzed Synthesis…"



Market Matrix
Framework Conditions

- Market share in Europe is currently <3%, as several biotechnological start-up companies have successfully established themselves in the product segment "enantiomerically pure carboxylic acids".
- Currently, only one "major customer" from the crop protection sector is in sight as a buyer. Over the next ten years, however, its competitors in the same class of active ingredients are likely to become active.
- In the future, mergers and centralization of the purchasing departments will most likely increase their power as customers.

- Quality leadership as a reliable manufacturer of a high-purity, chiral α-hydroxycarboxylic acid. Lean production and administration processes with flexible delivery dates and delivery times.

R&D Project "Nitrilase-Catalyzed Synthesis…"

Market Position:

Criterion	Weighting	Assessment	Weighting x Assessment
Market Share	04	01	04
Internal Consumption	01	01	01
Earnings Position	05	03	15
Logistics	03	04	12
Marketing Expertise	03	03	09
Product Qualität	05	05	25
Customer Structure	04	01	04
Product Range	04	02	08
Total	Σ 29		**Σ 78**

Scaling Factor	**100/145 ≈ 0,69**	**78 x 0,69 =**	**53,82**

R&D Project "Nitrilase-Catalyzed Synthesis…"

Market Attractiveness:

Criterion	**Weighting**	**Assessment**	**Weighting x Assessment**
Market Growth	04	→ 04	16
Market Volume	03	03	09
Displacement/Substitution	01	03	03
Market Access Barriers	01	04	04
Earnings Prospects	05	→ 02	10
Supplier Structure	04	04	16
Customer Structure	04	→ 02	08
Environmental Situation	04	03	12
Total	Σ 26		**Σ 78**

Scaling Factor	**100/130 ≈ 0,77**	**78 x 0,77 =**	$\boxed{\textbf{60,06}}$

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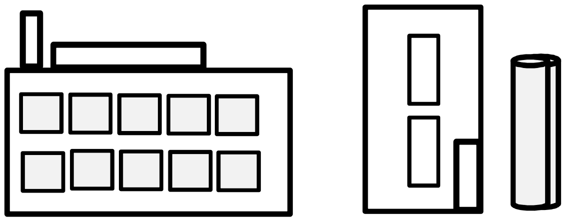
R&D Strategy: The Planning of a Project Portfolio

R&D Project "Nitrilase-Catalyzed Synthesis…" :

[…GmbH 2]



Technology Position: **85**

Technology Potential: **83**

Market Position: **54**

Market Attractiveness: **60**

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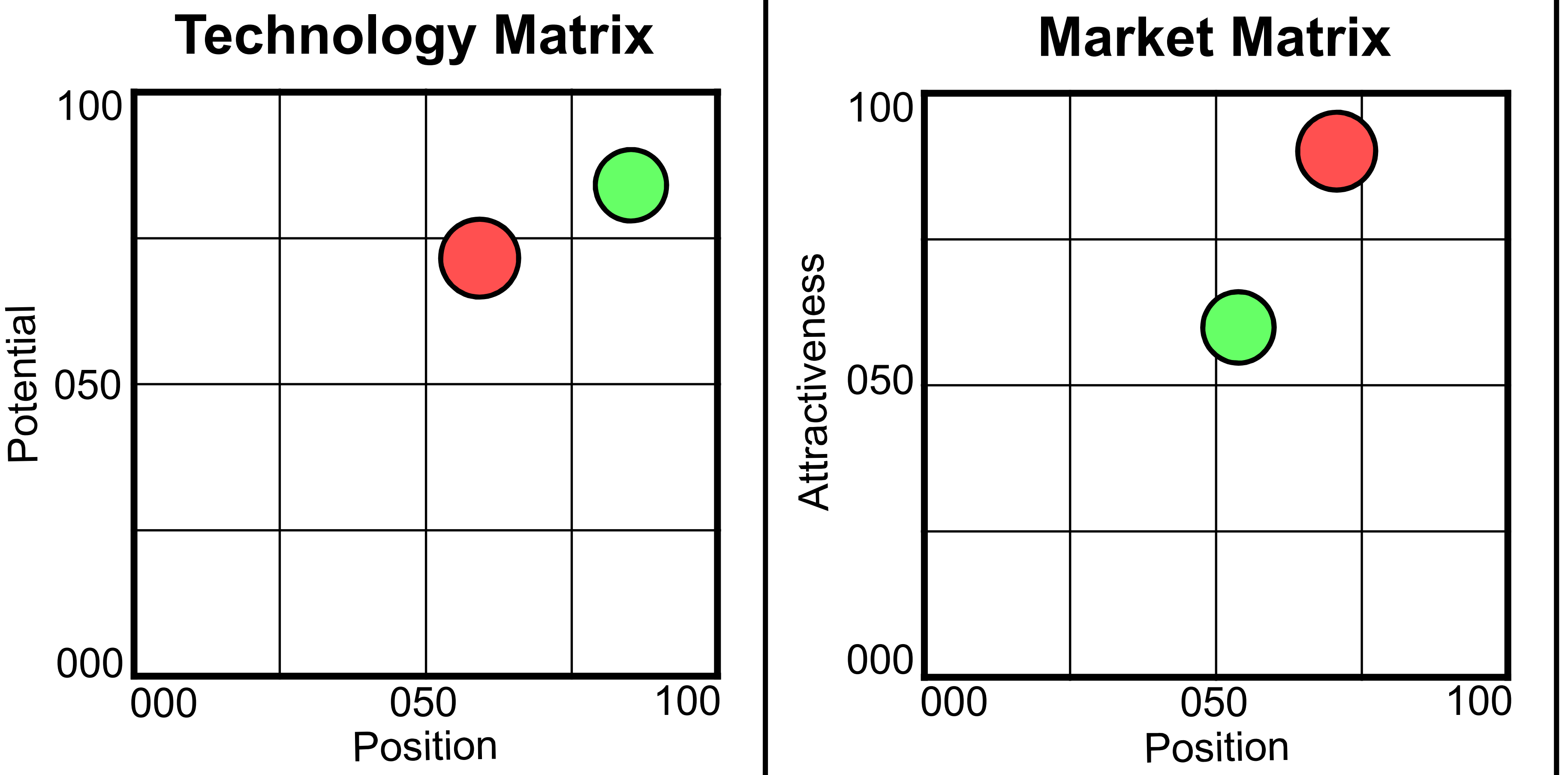
R&D Strategy: The Planning of a Project Portfolio

R&D Project "Nitrilase-Catalyzed Synthesis…" ( ):



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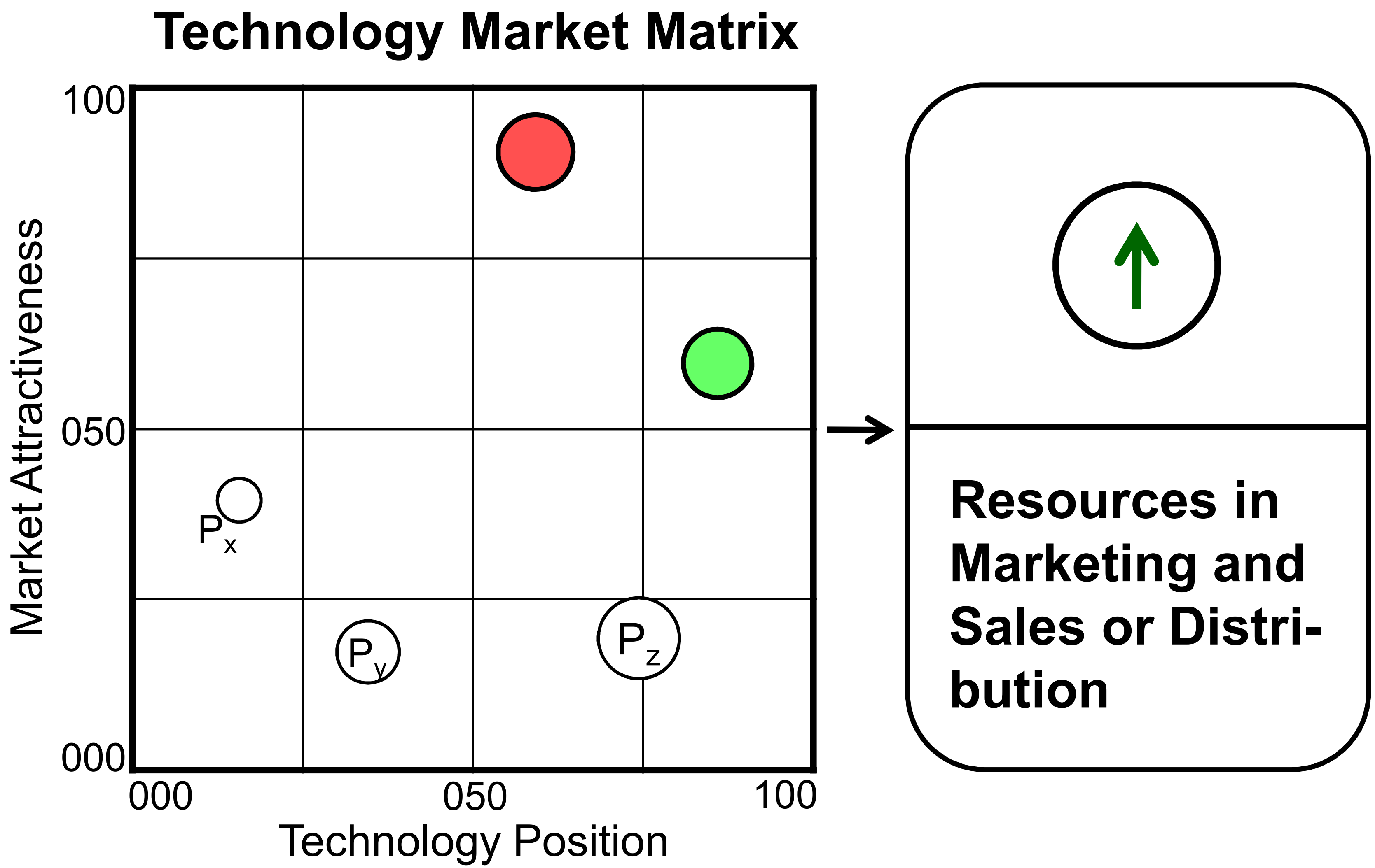
R&D Strategy: The Planning of a Project Portfolio

R&D Project "Nitrilase-Catalyzed Synthesis..." ( ):



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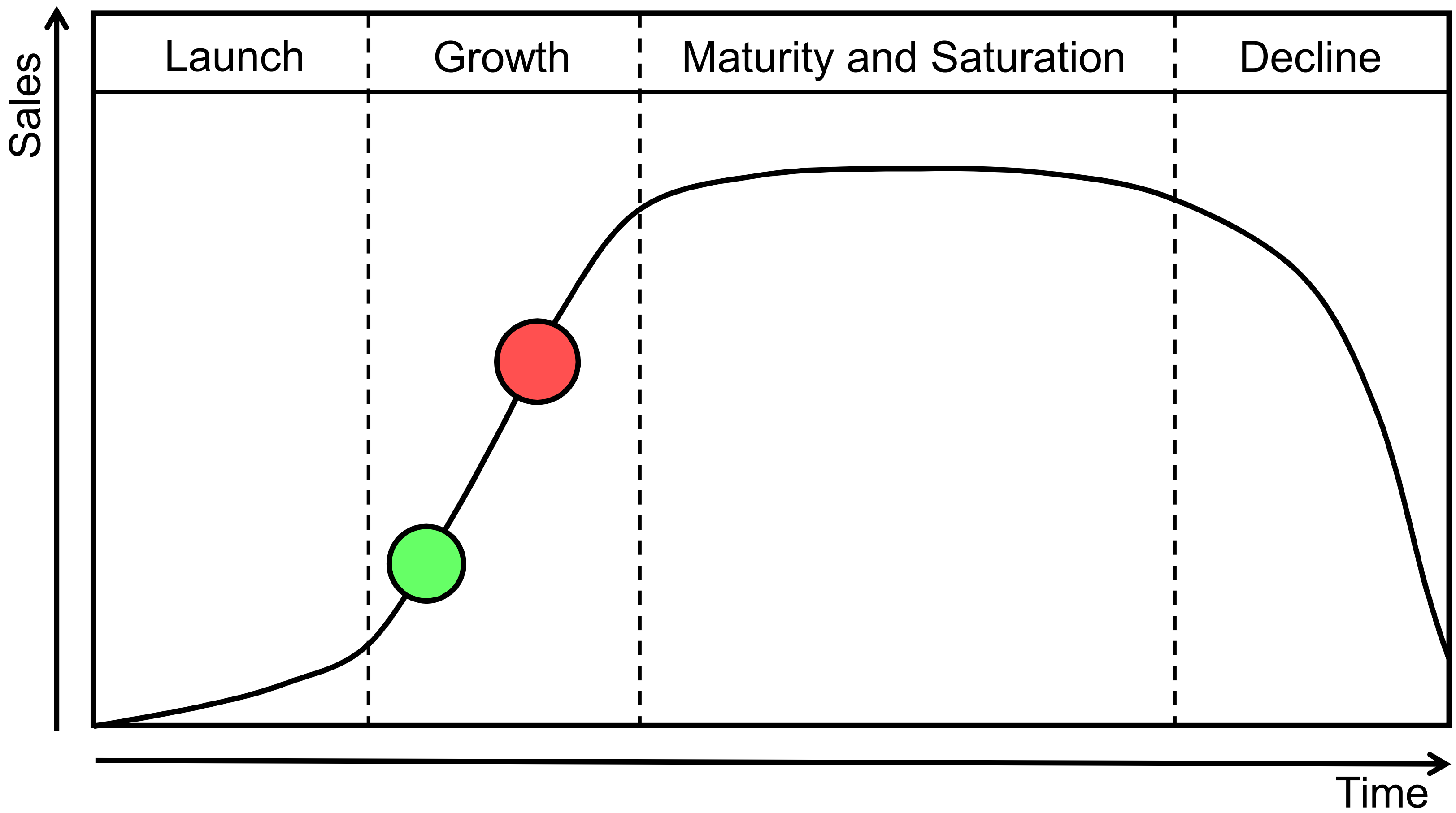
R&D Strategy: The Planning of a Project Portfolio

R&D Project "Nitrilase-Catalyzed Synthesis…" ( ):

Life Cycle Position



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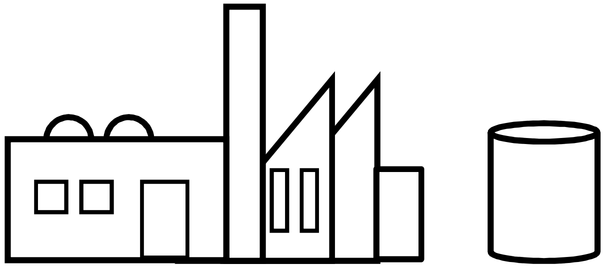
Example P3

Portfolio Planning:
Positioning of a R&D Subproject.

Subproject	**"New Metal Organic Frameworks for the Adsorptive Storage of Hydrogen Gas".**

R&D Strategy: The Planning of a Project Portfolio

Subproject "New Metal Organic Frameworks…..Hydrogen Gas".



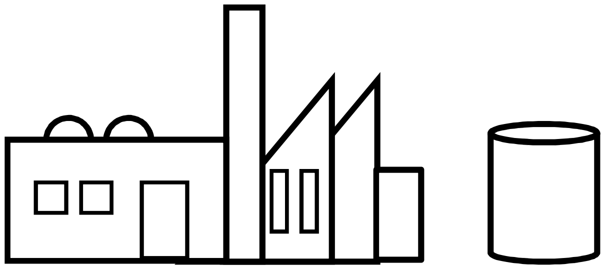
The Chemical Company "[…GmbH 3]":

Smaller, medium-sized company: 127 employees across Europe, including 11 chemists, 17 engineers (FH), 5 engineers (TU). Manufacturer and distributor of special metal organics.

Own research and development, own production. Active for 12 years in R&D, scale-up and contract manufacturing of Metal Organica.

Organic specialty chemicals: Production and distribution of TMA (Trimellitic anhydride) and PMA, (Pyromellitic anhydride).

Subproject "New Metal Organic Frameworks…..Hydrogen Gas".



→

Technology Matrix
Framework Conditions

- Urgently necessary investments in the expansion of the pilot plant for the vacuum drying of highly porous materials are already emerging today. The best possible chemical engineering needs to be clarified in the medium term.
- At present, there are only informal contacts with universities elaborating first-class research results in the MOF sector. Future, very close and exclusive cooperations are planned.

- Best possible raw material situation: TMA and PMA are produced as pure substances in-house. There is a reliable supplier of $Zn(NO_3)_2$ in own company holding.
- Owners of key patents with long durations in each case. The focus is on highly porous materials with excellent gas storage capacity.

Subproject "New Metal Organic Frameworks…Hydrogen Gas"

Technology Position:

Criterion	Weighting	Assessment	Weighting x Assessment
R&D Competence	04	→ 02	08
Procedures	05	04	20
Product Performance	05	05	25
Raw materials/Intermediates	05	→ 05	25
Facilities/Infrastructure	04	→ 02	08
Patents/Licenses	05	→ 05	25
Costs	03	05	15
Total	Σ 31		**Σ 126**

Scaling Factor	**100/155 ≈ 0,65**	**126 x 0,65 =**	$\boxed{\textbf{81,9}}$	

Subproject "New Metal Organic Frameworks…Hydrogen Gas"

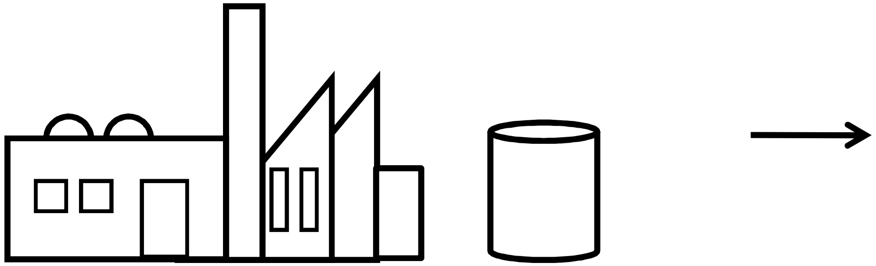
Technology Potential:

Criterion	**Weighting**	**Assessment**	**Weighting x Assessment**
Innovation potential, R&D	04	→ 05	20
Procedures	05	03	15
Product performance	04	→ 05	20
Raw materials/Intermediates	04	05	20
Facilities/Infrastructure	04	→ 03	12
Patents/Licenses	05	04	20
Costs	03	04	12
Total	Σ 29		**Σ 119**

Scaling Factor	**100/145 ≈ 0,69**	**119 x 0,69 =**	$\boxed{\textbf{82,11}}$

Rainer Buerstinghaus

Subproject "New Metal Organic Frameworks…..Hydrogen Gas".



Market Matrix
Framework Conditions

- Market share in Europe is currently <2%, as numerous start-up companies are active in this product segment in cooperation with universities.
- At present, no "pilot customer" with sufficient technical competence and market experience in the field of hydrogen storage is in sight.
- Over the next five years, M&A are very likely in the business with industrial gases. This will give potential buyers of MOFs a high procurement power.
- Authorization restrictions on the part of the European authorities of MOFs with heavy metal containing "connector-elements" for other applications are already apparent today. At best, niche market.

- High flexibility for the timely delivery of customers with a high-quality product through a streamlined production process and parallel to this, swift administrative processes.

Subproject "New Metal Organic Frameworks…Hydrogen Gas"

Market Position:

Criterion	Weighting	Assessment	Weighting x Assessment
Market Share	04	→ 01	04
Internal Consumption	02	01	02
Earnings Position	03	04	12
Logistics	03	→ 04	12
Marketing Expertise	05	→ 02	10
Product Qualität	04	→ 04	16
Customer Structure	04	→ 02	08
Product Range	04	03	12
Total	Σ 29		**Σ 76**

Scaling Factor	**100/145 ≈ 0,69**	**76 x 0,69 =**	$\boxed{\textbf{52,44}}$

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Subproject "New Metal Organic Frameworks…Hydrogen Gas"

Market Attractiveness:

Criterion	**Weighting**	**Assessment**	**Weighting x Assessment**
Market Growth	05	03	15
Market Volume	03	→ 02	06
Displacement/Substitution	02	03	06
Market Access Barriers	04	→ 02	08
Earnings Prospects	05	03	15
Supplier Structure	03	03	09
Customer Structure	03	→ 01	03
Environmental Situation	03	→ 02	06
Total	Σ 28		**Σ 68**

Scaling Factor	**100/140 ≈ 0,71**	**68 x 0,71 =**	$\boxed{\textbf{48,28}}$

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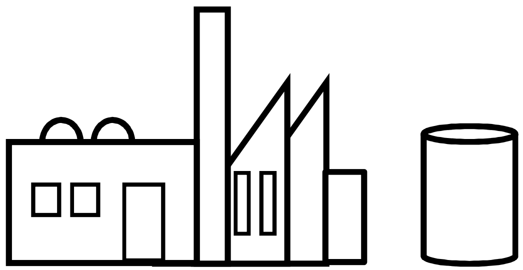
R&D Strategy: The Planning of a Project Portfolio

Subproject "New Metal Organic Frameworks…..Hydrogen Gas".

[…GmbH 3]



Technology Position: **82**

Technology Potential: **82**

Market Position: **52**

Market Attractiveness: **48**

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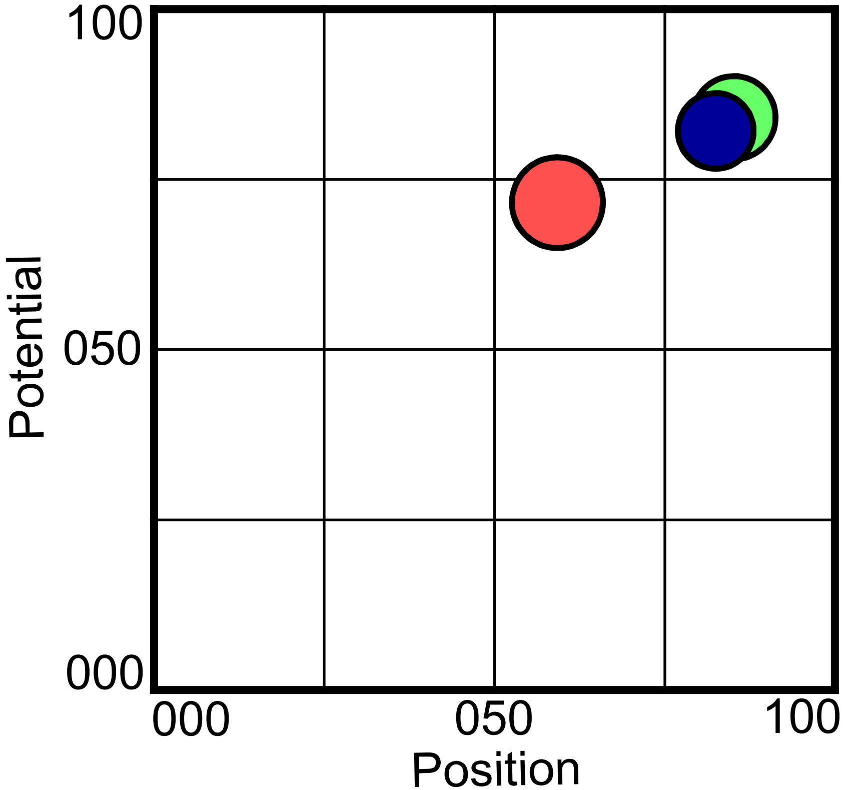
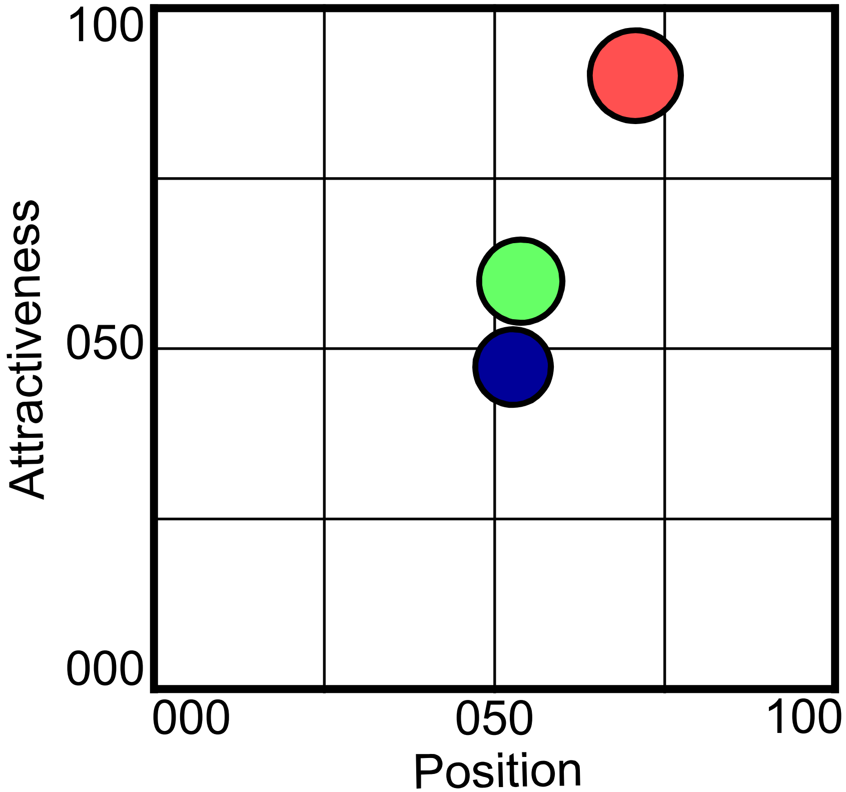
R&D Strategy: The Planning of a Project Portfolio

Subproject "New Metal Organic Frameworks..." ( ):

Technology Matrix



Market Matrix



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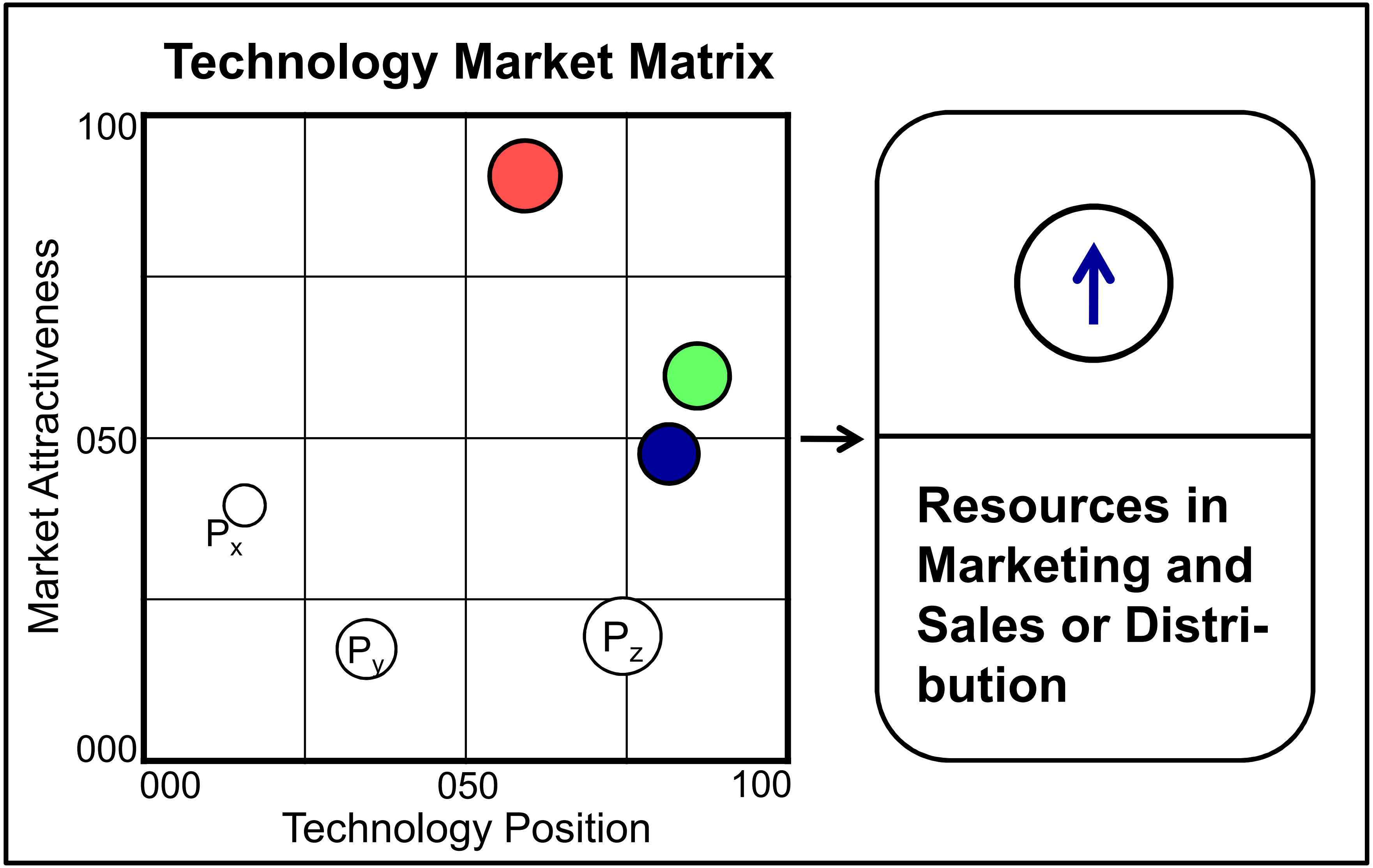
R&D Strategy: The Planning of a Project Portfolio

Subproject "New Metal Organic Frameworks..." ( ):



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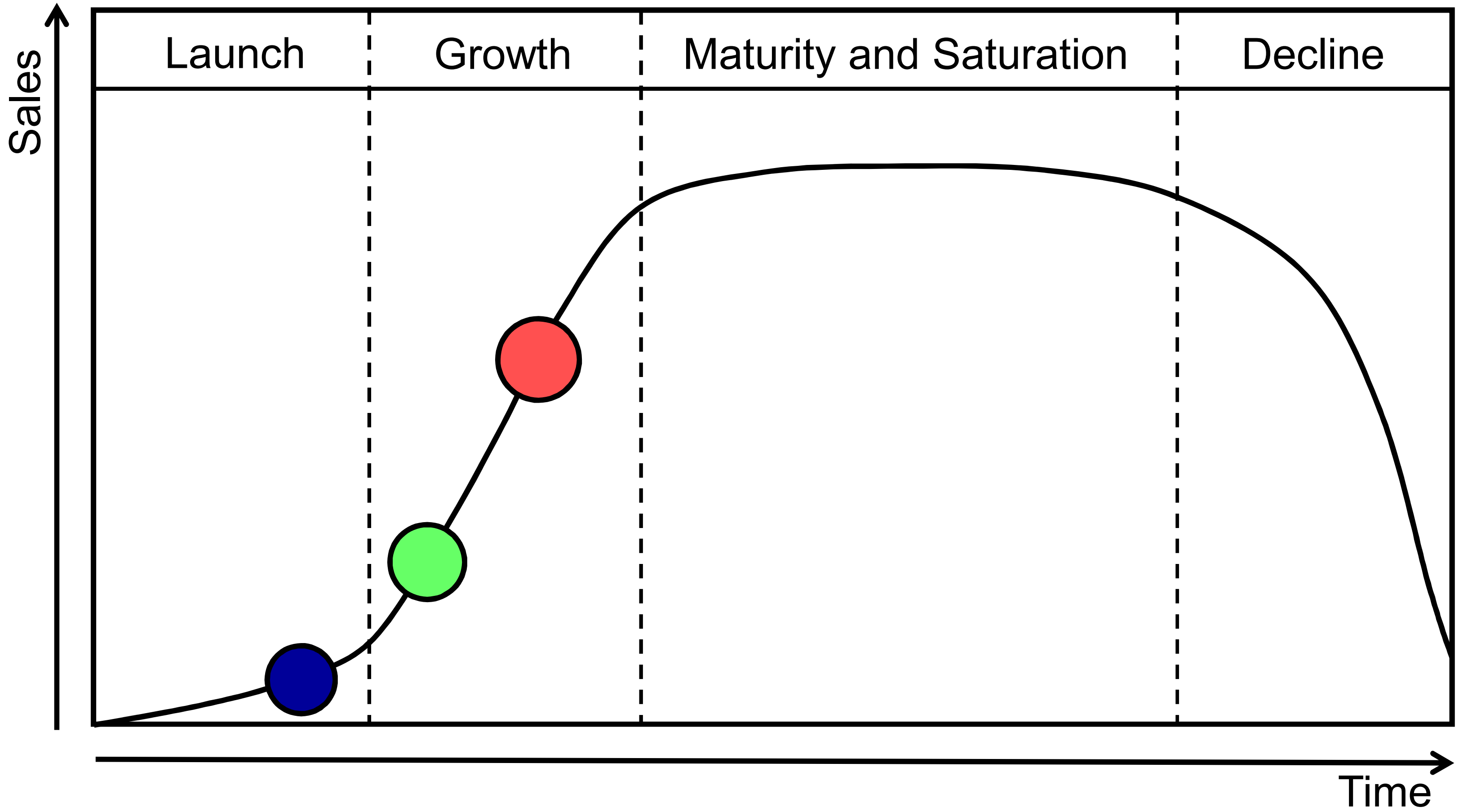
R&D Strategy: The Planning of a Project Portfolio

Subproject "New Metal Organic Frameworks…" ( ):

Life Cycle Position



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R&D Project Management
in the Chemical Industry

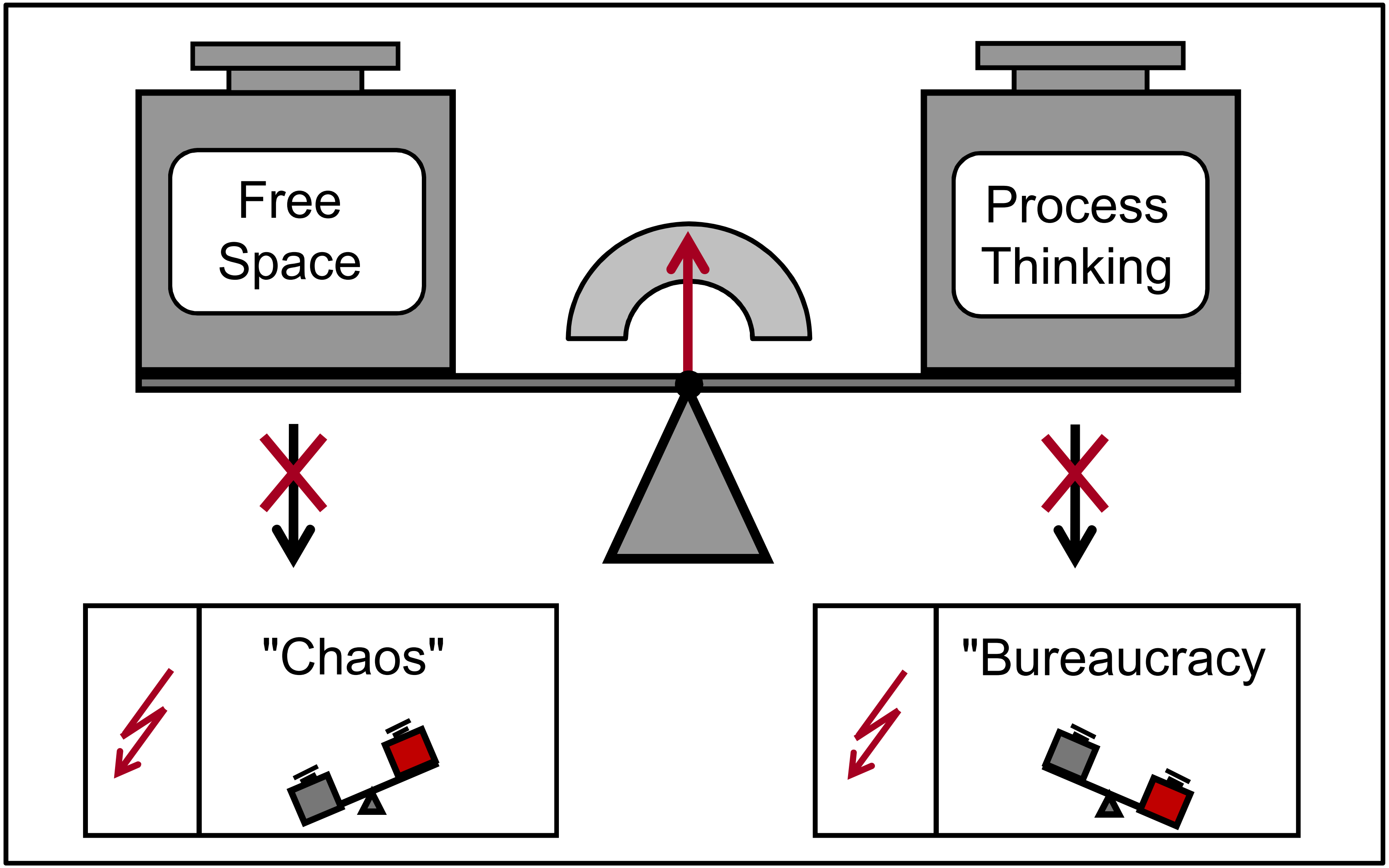
At the End….

The Subject Matter

▪	Innovations: Characteristics, Measures for its Promotion, Process Variants.	√
▪	Three Examples for Innovation Projects (Chemistry and Technology): 1. Highly Elastic Clear Coats for the OEM Automotive Sector. 2. Nitrilase Catalyzed Synthesis of a Chiral Hydroxy-Carboxylic Acid. 3. New Metal-Organic Frameworks for the Adsorptive Storage of Gases.	√
▪	Projects, Target Systems, Project Management in R&D.	√
▪	Appropriate Organization and Effective Structure Planning of R&D Projects.	√
▪	Project Flow Planning, Milestones, the Stage-Gate®-Process, Network Diagrams.	√
▪	Effective Implementation and Control of R&D Projects, Trend Analyses.	√
▪	Success Risks: Identification, Classification and Treatment.	√
▪	Recruitment and Lead of Project Staff: Chemists (m/f/d) – Team Players, Pacemakers and Executives in Projects.	√
▪	Project Manager (m/f/d): Tasks, Leadership Functions and Personality Profile.	√
▪	The Systematic Evaluation of Individual R&D Projects.	√
▪	R&D Strategy: The Planning of a Project Portfolio.	√

R&D Project Management in the Chemical Industry

Balanced, reasonable and with a sense of proportion!



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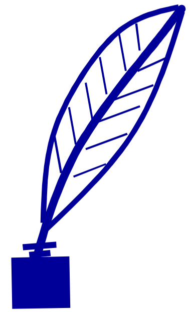
Balanced, reasonable and with a sense of proportion!

“It’s not enough to know,
you also have to apply it!
It’s not enough to want,
you also have to do it!“



According to **Johann Wolfgang von Goethe**
(1749 – 1832)

Limits of its Capability (!)

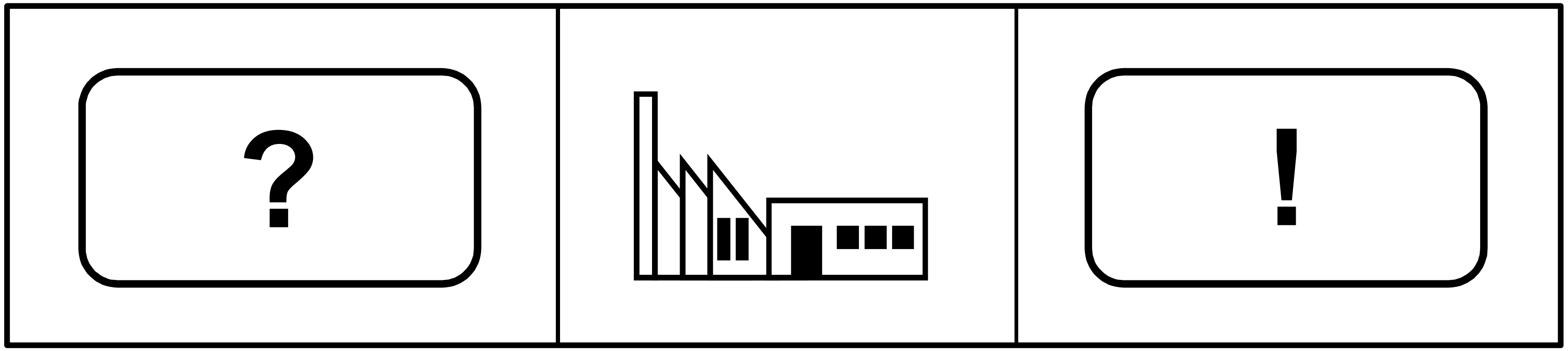
".... ***and just as little inventions can be compelled through project management itself!*** *..."*

*"...**The substitution of the chemistry-idiot by means of the project-idiot** will certainly not be able to remedy the lack of innovation in Germany...."*

(Source: Prof. Dr. Axel Kleemann,
Nachrichten aus Chemie, Technik und Laboratorium.)

At the End of this Lecture Module: **Key Messages** for You as Future Head of Research Projects (Industry)!

Not solely Visions:	→	**Brilliant Ideas!**
Not solely Intentions:	→	**Targets!**
Not solely Initiatives:	→	**Projects!**
Not solely Meetings:	→	**Actions!**
Not solely Explanations:	→	**Results!**
Not solely Scientific Discoveries:	→	**Substantial Operating Results!**



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At the End of this Lecture Module: **Key Messages** for You as Future Head of Research Projects (University)!

Not solely Visions:	→	**Brilliant Ideas!**
Not solely Intentions:	→	**Research Plans!**
Not solely Initiatives:	→	**Research Projects!**
Not solely Discussions:	→	**Experiments!**
Not solely Explanations:	→	**Results!**
Not solely Scientific Findings:	→	**Publications with "Leverage"!**

?		!

Parts of the subject matter were explained in lectures/ seminars at the following research/innovation centers:

Place	Research / Innovation Center	Calendar Year(s)
Düsseldorf	Max-Planck-Institut für Eisenforschung	1988
Wuppertal	TAW, Technische Akademie Wuppertal	1991-1998
Dresden	Technische Universität Dresden	1992
Bonn	Vereinigte Aluminium-Werke AG, VAW	1993
Erlangen	Friedrich-Alexander-Universität Erlangen-Nürnberg	1994
Potsdam	Max-Planck-Institut für Kolloid- und Grenzflächenforschung	1995
Göttingen	Georg-August-Universität Göttingen	1998, 2002
Freiburg	Albert-Ludwigs-Universität Freiburg	1999, 2003
Kaiserslautern	Technische Universität Kaiserslautern	1999
München	Technische Universität München, TUM	1999
München	Ludwig-Maximilians-Universität München, LMU	1999, 2003
Leipzig	Universität Leipzig	2000
Bonn	Rheinische Friedrich-Wilhelms-Universität Bonn	2000, 2003
Köln	Universität zu Köln	2001
Marburg	Philipps-Universität Marburg	2001, 2003
Kiel	Christian-Albrechts-Universität zu Kiel	2001
Zürich	Eidgenössische Technische Hochschule Zürich, ETH	2002
Bielefeld	Universität Bielefeld	2002
Aachen	Rheinisch-Westfälische Technische Hochschule Aachen, RWTH	2002

R&D Project Management in the Chemical Industry

Parts of the subject matter were explained in lectures/ seminars at the following research/innovation centers:

Place	Research / Innovation Center	Calendar Year(s)
Düsseldorf	Heinrich-Heine-Universität Düsseldorf	2002
Würzburg	Julius-Maximilians-Universität Würzburg	2002, 2006
Cambridge / U. S. A.	Harvard University	2003
Frankfurt/Main	Dechema Gesellschaft für Chemische Technik und Biotechnologie e.V.	1996, 2003
Stuttgart	Max-Planck-Institut für Festkörperforschung	2003
Braunschweig	Technische Universität Braunschweig	2003
Regensburg	Universität Regensburg	2004
Heidelberg	Ruprecht-Karls-Universität Heidelberg, Catalysis Research Laboratory	2004, 2009
Bochum	Ruhr-Universität Bochum	2005
Ulm	Universität Ulm	2005
Wiesbaden	GVC/Dechema Jahrestagung	2005
Gießen	Justus-Liebig-Universität Gießen	2005
Karlsruhe	Universität Karlsruhe (TH), Karlsruher Institut für Technologie, KIT	2005, 2011
Mainz	Johannes Gutenberg-Universität Mainz	2007
Saarbrücken	Universität des Saarlandes	2008
Mülheim/Ruhr	Max-Planck-Institut für Kohlenforschung	2009
Essen	Universität Duisburg-Essen	2009
Münster	Westfälische Wilhelms-Universität Münster	2010, 2011, 2014, 2015, 2018
Rostock	Universität Rostock	2012

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End of Lecture Module 07

Rainer Buerstinghaus

	Dr. Rainer Buerstinghaus (*1949), Vocational Education and Professional Background
1967-1972	Study of Chemistry, Justus Liebig University of Giessen.
1972-1975	Doctoral Thesis in Organic Synthesis, Work Group of Prof. Dr. Dr. h.c. Dieter Seebach, Doctorate, Dr. rer. nat.
1972-1976	Scientific Assistant in the Basic Course "Organic Chemistry" at Justus Liebig University of Gießen.
1976-2009	Chemist in the BASF Group. Diverse activities within the research organization and in the HR area.
1999-2009	Chairman of the Chapter "Ludwigshafen-Mannheim" of Association of German Chemists, GDCh.
1999-2015	Lectureship at University of Heidelberg, Topic: "R&D-Project Management in the Chemical Industry".
2005-2020	Preparation and Support of Case Studies on GDCh/JCF-Training (K 414), "Certified Project Manager...".
2007-2021	Lectureship in the Study Module "Business Chemistry III, Chemistry and Business Studies", University of Zürich.
2010-2018	Lectureship at University of Münster, Topic: "R&D-Project Management in the Chemical Industry".
2011-2021	Chemical Expert for the Engineering Office "Schimmelpfennig + Becke GmbH", Münster.

R&D-Project Management in the Chemical Industry

End

Rainer Buerstinghaus