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PHILOSOPHY, STRATEGY AND PROCESS FOR CONNECTING ENGINEERING DESIGN AND BUSINESS INNOVATION

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ABSTRACT
"Strengthening the Innovation Power" is one of the key challenges for gaining and maintaining leadership in modern industry.
Nearly all companies would claim to strive for innovations, but hardly any has a fully developed, powerful innovation culture in place. Frequently there are "Innovation Management Processes" installed that focus on structuring the Process Management for Innovation Projects. In fast changing times, this is not enough. First it is crucial to identify the domain where it is most beneficial to the company as a whole to start initiating changes.
Companies that are able to perform permanent transformations are rare. These successful companies connect all functions to develop a clear picture of the future. They derive roadmaps on how to bridge the gap from the current situation towards the desired future. They transform their business model for enhancing the value creation and they face the challenge to anticipate the right products for future and new customer demands.
The question is: What are the hidden patterns of success of such companies that really to make the difference?

Keywords: Innovation, Picture of the Future, Strategy, Process Model, Innovation Roadmaps, Contradictions, Innowis, Measurement of Innovation Levels

1. IMPORTANCE OF THE EARLY PHASES OF INNOVATION PROJECTS
Several studies show that in particular early, fundamental decisions have great impact on the possible outcome later on. Companies feel that the situation in early orientation phases is fuzzy, unclear and characterized by unique, vague indications that can have great impacts later on. At the same time the situation is not stable. Consequently there seems to be no opportunity to define an oriented, systematic approach that can support in structuring early project phases for innovation. The challenge is, to find the orientation for the right and new questions despite of a diffuse situation regarding the future needs of the world.

Figure 1: Strategic Gap of Innovation Processes: There is a lack in structuring early phases!

The question is: Is there, nevertheless a fundamental scientific approach that can assist as guidance in this situation?

2. SCIENTIFIC BASIS FOR BUSINESS INNOVATION

When searching for attempts to facilitate early direction finding processes it becomes obvious that there must be a number of different faculties involved - each of which working in accordance to their own procedures within their domain-specific scientific framework.

In companies there are usually two significant groups that mainly influence the early decision making phases.

On the one hand there is the group of Business Development. They work on best practices for transforming companies from one business model to another. Over the time the group has developed their language and their own way to explain and express success pattern for business innovation [1], [2].

On the other hand there is the group of Engineering Design, concentrating on processes on how to design most powerful technological systems. To structure necessary realization processes domain specific models were developed, also resulting in a domain specific language [3],[4].

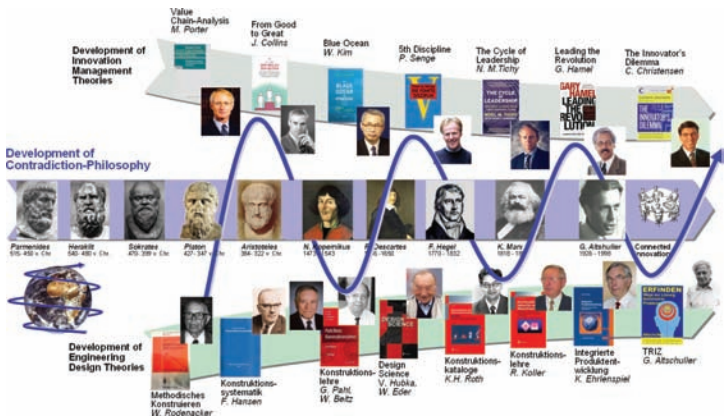


Figure 2: Innovation Philosophy as a Fundamental Science:
Building a common understanding of the future requires common mental models!

Asking scientific representatives of both domains, they confirmed - generally speaking – independently that there seems to be neither a need nor benefit for an intensive exchange between both faculties.

From the point of view of Engineering Design Scientists the Business Developers discuss “intangible, abstract issues without specific results”.

Business Developers regard the work of Engineering Designers as “performing the task of finding tricky solutions to detailed challenges” - work that needs to be done.

The challenge begins, as soon as companies need to find a way to build a common vision and strategy on how to change the current business in order to address future challenges. At this moment latest there is a lack of a shared understanding and common models. At this moment arises the strong need for a common language and a common work approach.

Trying to overcome this situation the question is: Is there a common scientific basis that could be used as a shared foundation?

On searching for this basis throughout all “Innovation-involved” disciplines the Philosophy could be identified as the science that is able to link all necessary partners.

Consequently, the fundamental definitions of the old Greek Philosophers should be useful to establish basic, common models.

The question is: Who do fundamental philosophical approaches support modern Business Innovation Challenges best?

3. PHILOSOPHY AND THE BUSINESS INNOVATION COLUMNS

Einstein has said: “Problems cannot be solved on the same level as they came from. Solving a problem is only possible on a higher thinking level.”

The science with the highest thinking level and at the same time the oldest and most general science is the Philosophy. It is the origin of the science itself.
The Philosophy defines the basic interdependencies of the structures and the developments in Natural Systems, Society Systems, Thinking-Cultural Systems and in modern times also in Technological Systems.

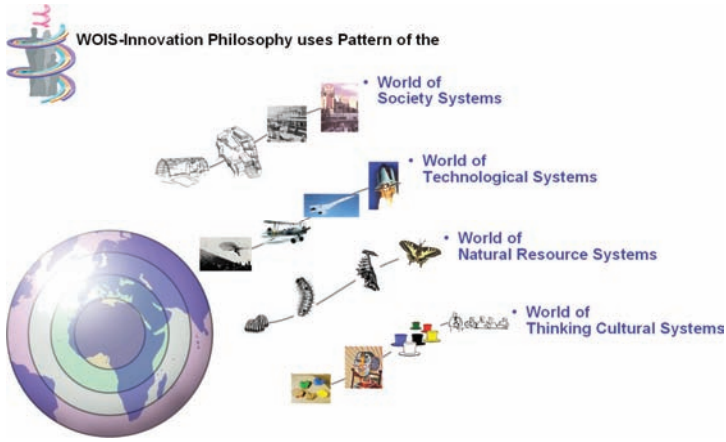


Figure 3: Innovation-Philosophical Pattern

This definition interconnects significantly more disciplines than only Engineering Design and Management. Using these philosophical categories leads to significant scientific fields that influence innovation processes.

- Natural Resource Systems include available Resources and the Value Creation Process
- Society Systems give perspectives on "Groups of Needs" and Jobs to be done.
- Technological Systems describe perspectives onto Products and relevant Functions
- Thinking Cultural Systems give perspectives on Organizations and Strategic Processes.

For each of which group exists scientific work that can assist in defining a general approach for Business Innovation. The following figure gives an overview on relevant literature.

Figure 4: Domains of Innovation Sciences

The question remains: If the Philosophy provides a general definition for a general segmentation of the world, how can this help building models for Innovation Processes?
Figure 5 shows the transformation of the fundamental philosophical categories to general Business Innovation Columns (BIC).
All businesses need to make money, the column of the "Resources" is split in two halves: The input resources as described above and "output" resources: The way how we spent and earn money and therefore the value creation process.

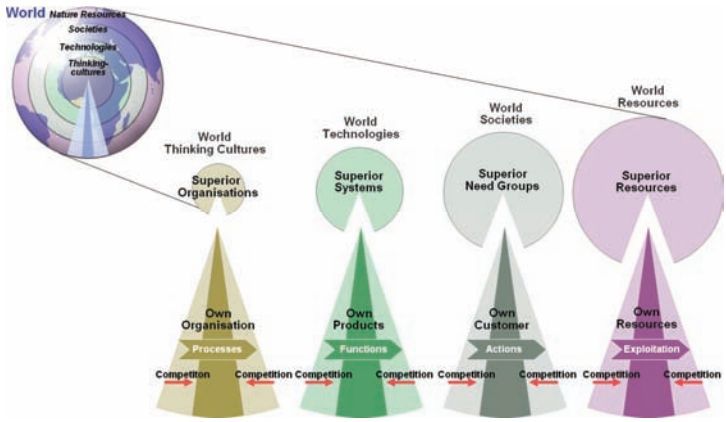


Figure 5: Business Development Columns-Build on four Innovation-philosophical Categories

3.1. Business Innovation Columns and the Value creation chain

The Model of the five Business Columns understands the company and its interdependency as a holistic system. For discussing business growth opportunities it is necessary to relate the business columns to the value creation chain.

In the picture below it is shown, that the business columns can be directly translated towards the value creation chain.

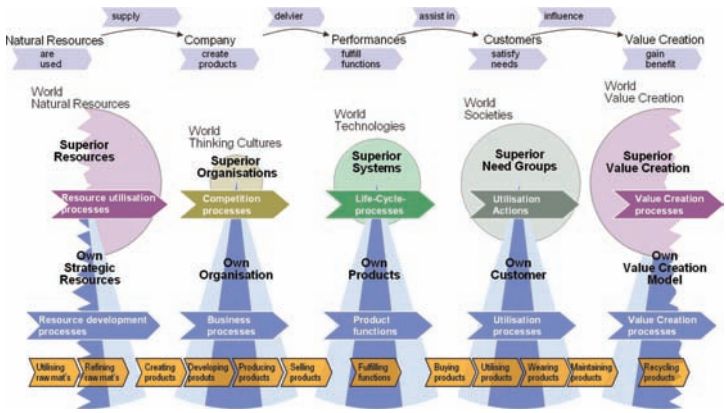


Figure 6: Business Innovation Columns and Value Creation Chain

The value creation model is also one of the reasons why the columns are arranged as they are: The logic behind is as follows - from the left to the right: “Natural Resources” are used to supply the “Company”. Companies have an organization and processes in place to create products. Products exist to deliver “Performances” by fulfilling functions.

These functions assist “Customers” in satisfying their needs, no matter whether it is a B2B, B2C, product or service that is supplied. The customers influence the “Value Creation” of the company by paying for the satisfaction of their needs, what helps the company to gain benefit.

Detailed process analysis for each of the steps within the value creation chain can help to identify innovation potentials. Especially the gap analysis between the own value creation model and the one from the superior system can usually help to indicate possible profit booster opportunities.

3.2. Philosophy and the spiral of innovation

Early Philosophers have defined three fundamental laws of dialectics:

a) The Unity and Polarity of the World (Shadow and Light)

b) The Transition from Quantitative Growth to a New Quality (Old, big TV sets ⇨ Flat LCD Screens)
c) The Negation of the Negation (historical wind mills ⇨ modern wind power generators).
It would be possible to write books on each of these laws, but the question now is, how they help with respect to defining a model for Business Innovation:
The first law "Unity and Polarity" says that there is no "on the one hand" – without an "on the other hand". This means, if there is an indeed tempting opportunity, where nothing stands against this – it is pretty likely, that the situation is not yet fully understood. To each target, there stands a counter-target. In front of each innovation, there stands a barrier. In short: There are bottlenecks of Innovation and Contradicting Challenges to be overcome to find inventions and to make innovations work.

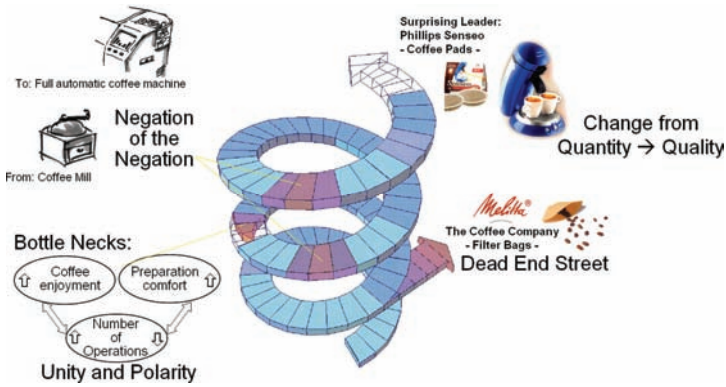


Figure 7: Spiral of Innovation, Including the Basic Laws of Dialectics

The second law "From Quantitative Growth to New Quality" means, that it is usually necessary, to allow quantitative growth – before it is possible to perform a change into a new quality.
This can be best explained by the example of education: Without knowing letters, reading is not possible. Without reading, studying is not possible. Without studying it is not possible to define solution opportunities to complex tasks. Each step in education requires first a quantitative growth of information, before this can be actively used as new know-how.
The third law "Negation of the Negation" means, that there have been quite frequently earlier attempts to find solutions to current challenges.
It would be a great waste of resources, not to look at these solution attempts. Due to modern materials, new control systems, the know-how of new people and all other modern possibilities it might be, that reusing the intension of the historical solution attempt might be the starting point for a new, modern development. Negation of the negation is meant to be understood as: "Old solutions are likely to come back, but on a higher development level with new success".
These three laws are the reason for using a "Spiral of Innovation" as a general model for explaining and challenging developments: There is no beginning and no end. Bottle Necks on the path show the need to overcome barriers. The sections of the spiral above each other indicate that developments form the history might reoccur.

3.3. Philosophy and the Model of Development Contradictions

In general it can be said that there is never a relevant opportunity without hurdles or risks.
This elementary truth is also represented by the basic dialectic law of the "Unity and Polarity" of the world: No Chance without Risk – No Opportunity without Hurdle – No New Field without Pressure on the Traditional Business.
In order to clarify the picture in fuzzy but complex situations it helps to formulate so called development contradictions:
Traditionally it is often discussed about "Target Conflict Management", by which "Best Compromises" are identified by trading off between two desired targets.

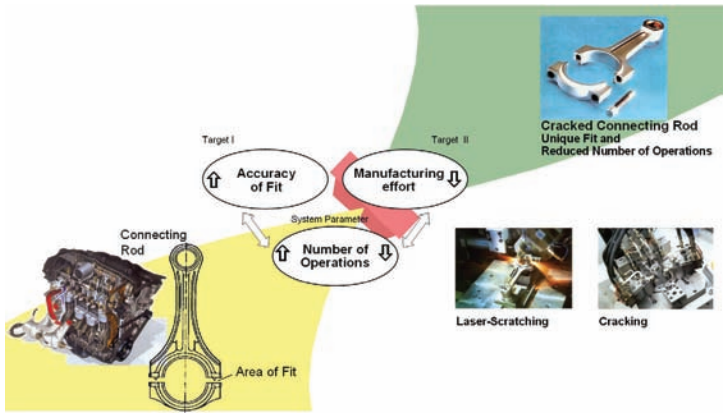


Figure 8: Pattern for Innovation: Solution to Contradictions

To systematically challenge innovations it helps to raise the bar by demanding the fulfillment of both targets. This creates a dead lock situation, as this is up to now not possible.
How to overcome such a dead lock situation?
Target Conflict Management Methods cannot help, as there is no leaver to grasp.
To be able to find a way out it is necessary to know the reason why both targets cannot be fulfilled at the same time.
The example of a Connecting Rod Development, shown above demonstrates this: If there is one target, to increase the accuracy of the fit for assembly – and on the other hand the counter-target to reduce the manufacturing effort at the same time, then this seems to be impossible.
A typical trade-off process would be to define the precession that can be manufactured without increasing the manufacturing effort too much.
Formulating a Contradiction a third element is introduced: The logic link that gives the reason "why" both targets cannot be fulfilled at the same time. In the example of the Connecting Rod: The number of operations required.
Formulating paradox challenges can help to challenge innovations: The logic link is: If the Accuracy of the Fit should be increased, the Number of Operations has to increase as well. If the Manufacturing Effort should be reduced, the Number of Operations has to be reduced. Therefore the "Number of Operations" is one underlying reason, why both targets cannot be fulfilled at the same time.
Against the conventional way of thinking it is a paradox challenge to think about "How to increase the accuracy of the fit – despite of reducing the number of operations required".
The innovative solution to this paradox challenge was to crack the connecting rod.
This results in a unique fit that requires laser scratching of the rated break point and the correct impulse to cracking without deforming the bore.
Such development contradictions do not exist for technological challenges only, but also on business level, such as on the one hand "Increasing New Market Potentials" and "Safeguarding the traditional business" on the other hand, connected by the "Concentration on Core Competences".
The question remains: How to relate the model of contradictions to the five columns of Business Innovation?

4. STRATEGY – THE INNOVATIVE SHORTCUT TO THE FUTURE

4.1. Conditions for Higher Development

Having the "Spiral of Innovation" available is useful, but not sufficient.
The spiral can only help to explain, why things are, as they are. The question is: How anticipating successful future developments? What conditions are needed to actively shape future developments? There are again, three "Development Conditions" that describe the environment that is needed to fertilize Business Transformation:

1. Remoteness of Equilibrium: The further development of systems necessitates a situation, where the system is far from equilibrium. This also applies to people: "Never stop to start something

new”

2. Entropy Export by Information Import: “Stupid Systems” need to be controlled in detail - sometimes departments are dying the death of Data Overflow. By importing additional information it becomes possible to link and to relate data to each other and thereby to implement “self-organizing” structures. Thereby data is transformed to applicable information and know-how.
3. Non-Linearity of the Interdependency: If one tries to burn a rat outside of his house – and the burning rat runs into the house and burns thereby the house – this is a typical non-linear interdependency. The example is a negatively strengthening one, but there are also positive factors, that can be used as profit boosters for modern Business Models. One example are modular structured product portfolios – with a strictly limited number of modules that need to be designed, tested and manufactured, but an extraordinary flexibility for customers to order their “tailor-made” product.

The model of the “Innovation Short-Cut” shows that a process consisting of three phases can be used to shortcut the Spiral of Innovation: An orientation phase that searches for new directions, a direction decision phase that summaries the challenges and a solution finding phase that develops roadmaps on how to overcome the challenges.

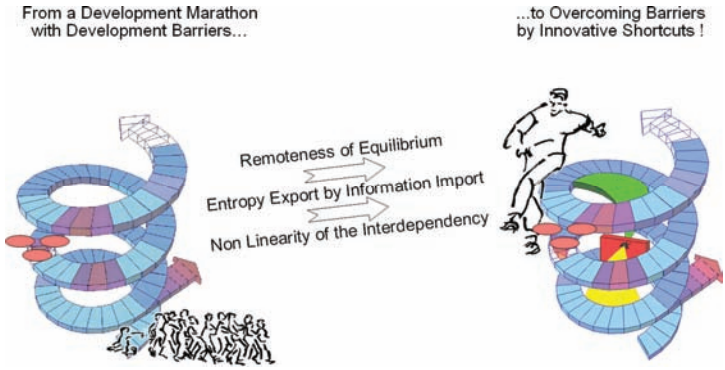


Figure 9: Intension for Business Innovation: Shortcutting the Spiral of Evolution

The question is: How do fundamental philosophical approaches support modern Business Innovation Challenges best?

4.2. Scientific Disciplines involved in innovation processes

To resolve this question it is first discussed: Which disciplines need to be involved in modern in discussions regarding “Business Innovation”?

Obviously in modern industry there are no meaningful solutions that do not support the return on investment for a company. Therefore it is essential to relate innovation opportunities back to their potential impact on the general value creation model. Thereby it is essential to understand that looking at cost saving opportunities only is a critically limited view only. More powerful are opportunities that enable benefit increasing – more effective – solutions.

Successfully implementing innovation opportunities requires to build a common understanding about the desired approach throughout the representatives of all involved disciplines. This necessitates, not to only utilize the available “Brainware” of individual experts, but to build a shared understanding regarding essential actions, timings and the desired overall effect.

As a consequence, psychological aspects are at least as important, as the expert domain know how to facilitate decision making processes.

As soon as innovation opportunities exceed the time frame of the next generation, or if the challenge is to open up new markets, it is usually hard to argue, whether the desired solution already fits well enough to future markets or not. Strategic Orientation Tools, such as Social and Technological Trends and Laws of Evolution can assist in measuring the innovation level and can provide an indication in how to develop further from a distinct point that could be achieved.

Frequently the discussion about “Innovation” is limited to products that a company offers.

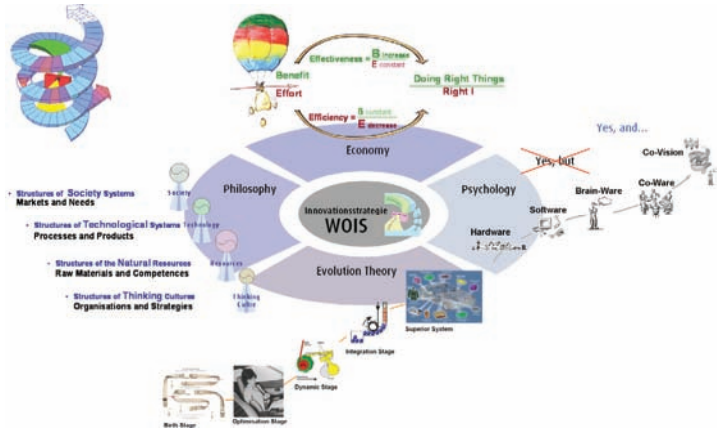


Figure 10: Searching for new Innovation Directions: Whom to involve, Where to look, How to inspire?

Looking at modern companies, it is frequently not only that product that is the underlying reason for the success. It can be also the strategic assets or supply chains, that the company use, unique processes that are in place or organization structures. Maybe there are USPs provided by the product, but more frequently there are innovative service concepts, as they are more difficult to copy.
Innovation opportunities can also arise form redefining the own view onto the market and thus identifying new or alternative market needs.
By relating the above mentioned innovation opportunities back to the business model, new models on "how are we going to make our money in future" can be identified.

4.3. The Strategy Model: Picture of the Future Development

The "Picture of the Future" characterizes the current situation of the company in relation to the competitors and to characteristics of "Superior Systems" on the bottom left hand.
This description concludes in the identification of three gaps: The first gap is the one between the company and the competitors and the second the one between the company and the superior system.
This analysis relates to the current situation.

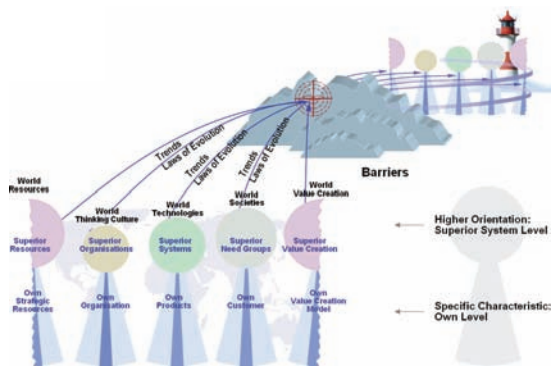


Figure 11: Picture of Future Developments

In general it is possible to indicate development directions for each of the columns of Business Innovation. This works best by analyzing the development over the last years and by using trend and "laws of evolution" analysis to anticipate what likely future developments will take place.
This analysis assists in building a "Picture of the Future" – that can be used as a "lighthouse" when working on detailed innovation opportunities for each of the columns.

At the same time the "Picture of the Future" indicates the third gap: The gap between the current situation and the future situation anticipated.
Each of the gaps can be characterized by a key contradicting challenge.
Knowing the characteristics of the current situation and by having anticipated a likely picture of the future it can be analyzed which of the existing gaps bears the greatest potential regarding the future growth of the business. This defines the key contradiction for the Business Development Project – that can set a product development challenge – or can also relate to any of the other columns.

4.4. Front Leveling for Business Innovation

Having identified innovation opportunities, the question remains how to organize the realization process, which departments to involve and where to start.
Most simply it could be argued that the realization responsibility should lay with the department that has to deliver the strongest contribution, but is this sufficient?
The following picture shows, how the German company Brose has developed over the last years.
The example demonstrates clearly, that it is necessary to "Front Level" between all columns and to consequently involve all departments in relevant changes.
When analyzing what is happening by transformation processes it becomes clear, why this is the case:
Within the current business model the situation is clear: With current "Strategic Resources" and current Know How the business operates "Known Processes" to "Manufacture Products" that are delivered via known sales channels to "Customers", what results in a "Return On Investment".

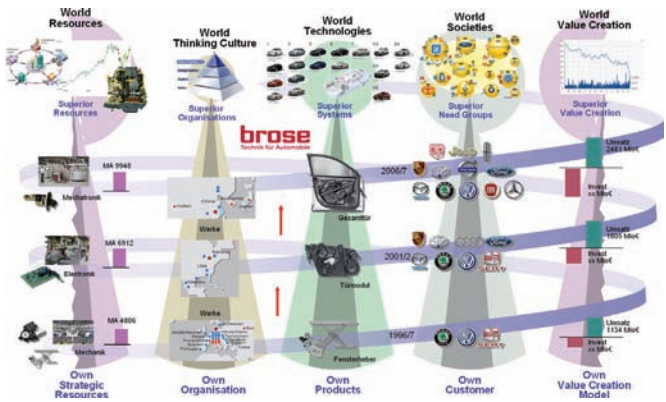


Figure 12: Business Innovation Columns and the Necessity for "Front-Leveling"

If only one element is significantly changed, the entire business model needs to be adapted to regain an optimized return on investment.
Looking at the example of Brose this can be characterized as follows:
In the past Brose manufactured mechanical window winders in Coburg, Germany and sold them to some customers. As the entire value creation chain had been optimized for this business model a step change within one of the columns requires adaptations of all others as well:
Brose expanded its operations to "door modules". This necessitated to develop additional electronic competences. Additionally such complex systems had to be delivered "Just in Time" – requiring an international expansion of the manufacturing facilities. Furthermore developing door modules needs more than just component delivery of window winders – thus the Brose development processes had to be interconnected to the ones of the customers.
When extending the Brose business to pre-assembled door systems, the international network had to be qualified for "Just in Sequence" services and additional mechatronic competences were required.
All developments had to be aligned to the requirements of the OEM's and the developments of their business models. The question remains: Is there a process that is able to guide the work of a team through a Business Innovation Process?

5. INNOVATION PROCESS AND STRATEGIC ORIENTATION FOR FUTURE DIRECTION FINDING

The discussion about the Business Innovation Columns shows, that the required analysis can be rather complex. Nevertheless already Einstein said "A model should be as simple as possible, but not more simple".

And as the world is complex, it would be negligent to try to develop a too simple model for describing future interdependencies.

Not to get lost in complexity fundamental philosophical categories can help to structure the work and to relate Strategic Orientation Tools to distinct analysis perspectives.

These fundamental categories are: Material, Space, Time, Energy and Information and the Self Movement as the underlying pattern of existence.

The most effective direction of searching for innovations is first: To think about the organization of self-movement. This describes the thought direction, that the system fulfills functions itself, by utilizing information in a more effective and efficient way, despite of reducing the effort for material, energy, space and time.

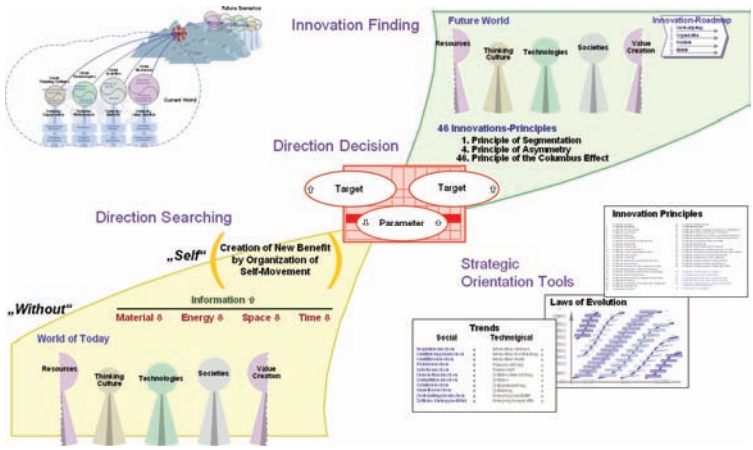


Figure 13: Strategic Orientation Tools for the Phases of Business Innovation Processes

Because this is rather abstract, it is useful to additionally use more specific strategic orientation tools, such as trends and laws of evolution for direction finding. Furthermore strategic orientation tools exist for the innovation finding phase as well. These are, for example, innovation principles for solving challenging contradictions.

The question remains: Is there a more detailed process that is able to guide the work of a team through a Business Innovation Process?

5.1. Process Model for business Innovation

Based on the experience of more than hundred innovation projects a process model could be developed over the past twenty years. It is based the three major project phases as mentioned earlier on: The Direction Finding – Direction Decision – Innovation Finding phase.

For each phase detailed analysis and strategic orientation tools exist. Within the Laws of Evolution there is one Law that is called "Completeness of the parts of a system".

The question remains: When can a system be called "complete"?

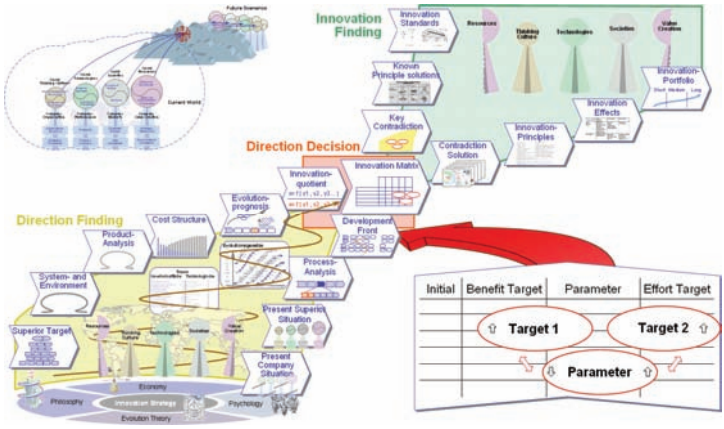


Figure 14: Process Steps and Innovation Technology for Business Innovation

5.2. Measuring the innovation level of systems

Frequently project teams face the question to judge the innovation level of existing or desired solutions. Decisions regarding the innovation level are frequently taken on subjective evaluation of the overall system.

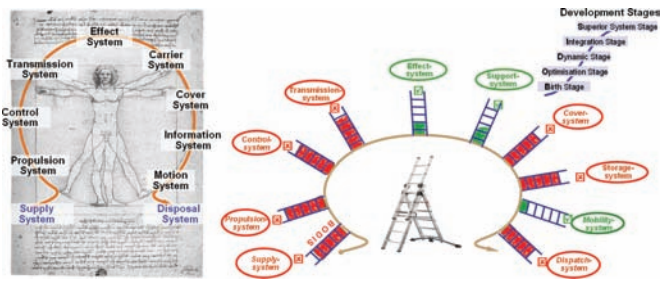


Figure 15: Measuring the Innovation Level:
The Organism-Model and Sub-Systems with their distinct Level of Innovation

Such approaches face two major weak points: First they do not provide a generally applicable structure. This is necessary to have a frame that gives an indication whether a system is complete or not. Especially simple systems need to give the answer if they already developed all possible sub-structures to be independently or not. For complex systems such a structure could help, not having to analyze each component, but to run the analysis on a sub-system abstraction level.

The question was: How to define such a generally applicable structure.

The answer could be extracted from the general blueprint of organic systems: All of them consist of ten sub systems: They perform a function by their “Effect System”. To be able to perform the Effect they need be connected to their environment by a “Supply System”. This needs to supply a “Propulsion System” that needs to be regulated by the “`Control System”. The “Transmission Systems” connects the Effect System to the Supply System. To stabilize a structure a “Support System” is required. Each system has it’s boundaries that are defined by the “Cover System”. A great difference between simple organisms and more complex ones is the ability to be able to fall back on a “Storage System”. A further difference between simple and more complex systems is the existence of a “Mobility System”. And if there is a Supply System, there also needs a “Dispatch System”.

Using this structure opens up several analysis perspectives:

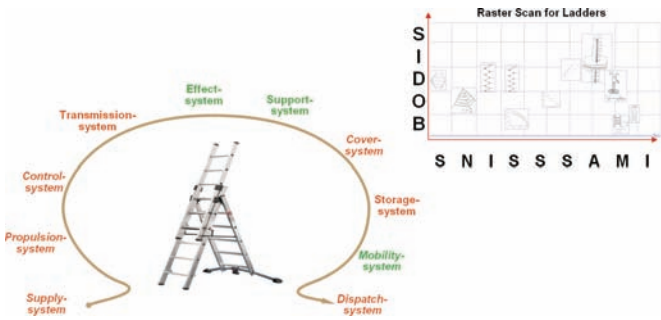
First in can be checked, whether all systems are already developed or not

Second the structure can be combined with Strategic Orientation Tools, such as Laws of Evolution.

It can be judged, for each sub system independently, on which development level each of the sub system has already arrived.

The figure above shows a ladder as a fictive and simple example: Ladders are not supplied with energy, space or information. Consequently this sub-system is shown in red. If there is no supply, there can be no propulsion and also no control. The effect system of ladders seems to be optimized, as there is already a structure on the bars. Yet the Effect System seems to be not fully developed. At least it is not dynamic, there are no additional functions integrated and no superior system is build up to now.
As conclusion it is not the intension to follow for each sub system all possible development directions, but the organism model is meant to demonstrate the field of innovation opportunities. It depends on the discussion of the interdependencies of all Business Innovation Columns to decide what is most promising and what has less potential.
It is important to understand, that the organism model can be applied to specific products but with the same strength also to all other kinds of systems such as organizations.

5.3. Rasterscan for innovation



Raster Scan for Innovation:
Figure 16: Sub-Systems and the Level of Innovation of their Design Characteristics

The Sub-System Structure can also assist in developing innovation opportunities to contradicting challenges. With the "Raster Scan for Innovation" each sub system can be characterized by distinct design parameters, such as "Size", "Number", "Orientation", "Shape", … to then systematically challenge the current innovation level. For example: If the size is currently optimized, it could be a potential, to change the size to become adaptable (dynamic).

6. CONCLUSION

INNOWIS stands for INNOvation WISdom. INNOWIS is meant to be understood as the ability of a company to pull all necessary know-how together to be able to create a common regarding the companies' future. To conclude, Business Innovation requires three columns:
These are: Common Models for a shared understanding for Innovation, common Innovation Know How and a Culture for Innovation, as well as Processes to guide a team through Business transformation processes. This approach is used in a lot of industrial projects. It's further development is a permanent ongoing process.

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