ProHEAL Basics – Extended Version

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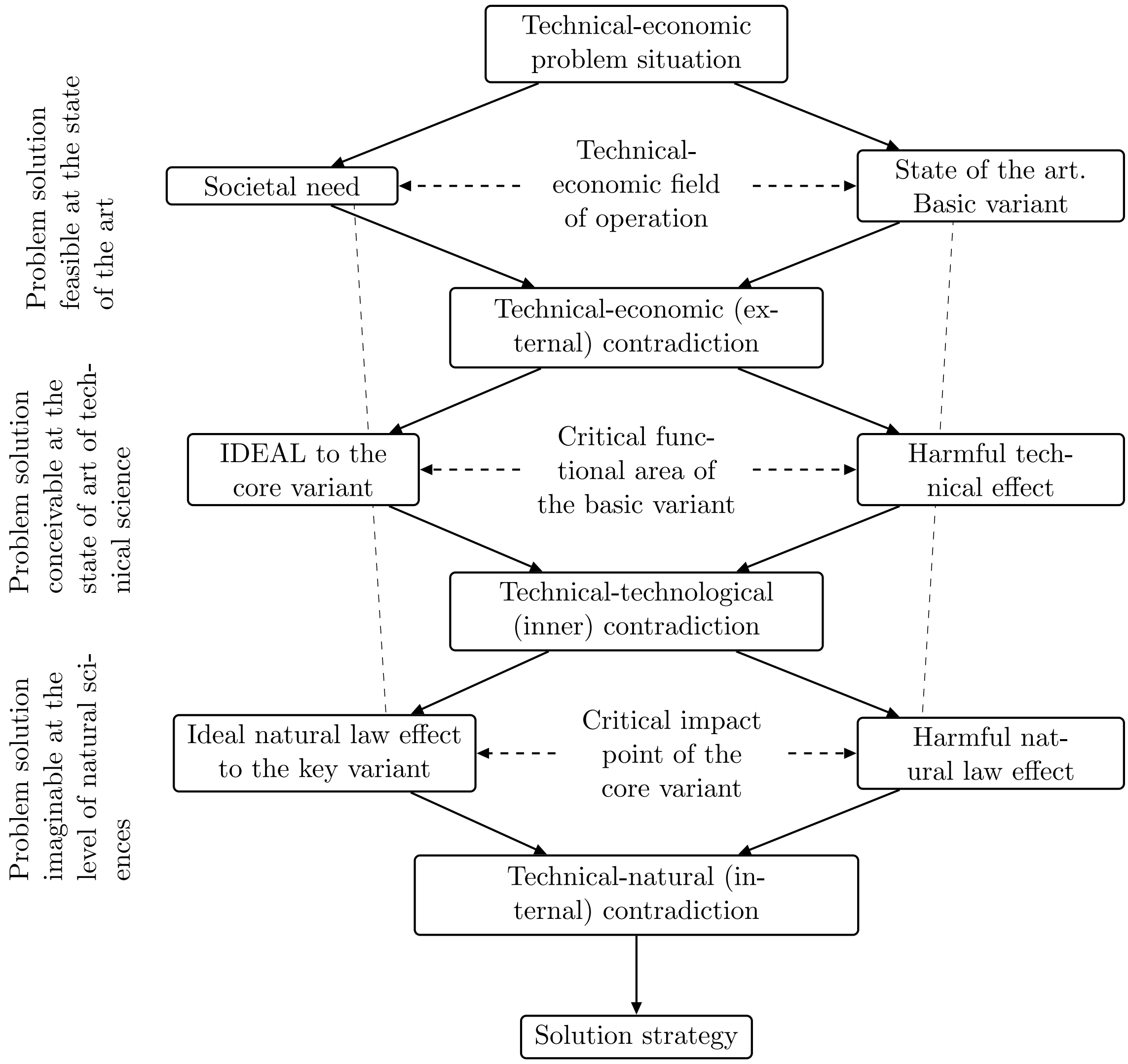
1 ProHEAL Basics – a Short Overview



2 The problem area levels in the ProHEAL path model

The ProHEAL path model provides for a graded structuring of the problems in different problem field levels as manageable sections of a solution path and thus creates for the first time the necessary prerequisites for systematic application of various methodological instruments for determining the current location of the real core problem.

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2.1 The technical-economic problem area level

At this first level, all problem-determining facts come into consideration that the social need in the sense of a potential need for a solution and the status of technology as a system of available technical products and processes in the sense of a potential solution offer.

The consideration is person- and process-related and determined by the product-goods-purpose relationship.

Results in this problem area level are

- the technical and economic objectives of an innovation project,
- the *basic variant* of a process or product innovation that is tailored to the technological requirements,
- the *critical functional area* in the multi-dimensional optimization behavior of this basic variant,
- the *technical-economic contradiction* (TEC) that prevents an optimal design and tayloring of the basic variant.

If there is no basic varaint that can be optimized in terms of the technical-economic objective, we are faced with an inventive problem that is to be analyzed at the next level on which the solution of the TEC is the aim of the invention.

2.2 The technical-technological problem area level

At this next level, all the facts are considered that affect the technical system of the basic variant, its structure, function, its behavior and its immediate technological environment.

The consideration is object- and function-related and determined by the technical means-action-counteraction relations.

Results in this problem area level are

- the in the sense of solving the TEC *ideal technical subsystem* in the critical functional area of the basic variant,
- the *undesired effects* as not inteded, technically disadvantageous influence of the ideal subsystems on the functional behavior of the basic variant,
- the *critical operational area* in the functional structure where the causal interdependency of the ideal subsystem and the undesired effects are located,
- the *technical-technological contradiction* (TTC), that prevents to eliminate or suppress the undesired effect by varying the functional principle of the ideal subsystem.

If a technical subsystem with an alternative functional principle for the critical functional area of the basic variant can be found without causing a significant undesirable side effect, then we obtained an invention as a solution to the TEC. Due to the heuristic approach, this often turns out to be located in the low-tech area, as "surprisingly simple solution (SSS)" that in the best case only requires a technical trial run as application.

If the solution at this problem area level is not achieved, the problem situation has to be formulated as invention task that contains the TTC as well as a solution strategy tailored to this contradiction. This aims at defining the harmful natural laws in the critical operational area of the functional structure and to replace it with an alternative, known operating principle. We move forward to the third problem field level.

2.3 The technical-scientific problem field level

At this third level, all facts come into consideration that concern the operating principle, the requirements for its technical use as well as its theoretical and experimental basics.

The consideration is model- and event-related and determined by the field-factor-effect relationships.

Results in this problem area level are

- the *ideal operating principle* that solves the TTC in the critical operational area of the functional structure,
- the *harmful natural law* that prevents the technical deployment of the ideal operating principle,
- *new technical-constructive boundary conditions* in the critical operational area, which suppress the effects of the harmful natural law,
- the *technical-scientific contradiction* (TSC), which prevents the development of the ideal principle by varying the technical-constructive boundary conditions in the critical operational area.

If the new operating principle can be technically unfolded in the necessary dimensions to ensure the fulfillment of the function in the critical range, we are faced with an invention as a solution to the TTC. Since this enters new technical-scientific territory, the solution is usually in the high-tech area. It requires for its verification application-oriented fundamental research.

If a solution to the problem cannot be found in this way, we are faced with a system-immanent TSC, that questions the development and viability of the system as a whole. The solution strategy then requires the search for a suitable, so far unknown operating principle or a fundamental process innovation. Both solution strategies usually go beyond the scope of a timely and financially definable innovation project. They were therefore not subject to further methodological considerations in the inventor school, insofar as they could not based on corrections of the existing process and a corresponding new solution for the basic variant.

3 The ABER matrices as a strategic tool in the invention methodology

For the path model through the problem field levels, the invention methodology proposes a set of methodological instruments, which from its heuristic application characteristics includes three categories of tools and techniques:

- *Strategic tools* for goal and route planning, for working out the problem-determining contradiction at each level and to find solution strategies to overcome such a contradiction. These tools differ in the three problem area levels and have an inventive method specifics.
- *Tactical tools* for the procurement and processing of information, for the generation of solution variants and their evaluation according to given solution strategies.
- *Creativity techniques* to activate and strengthen intuition, imagination and fluency in thinking and the ability to abstract, associate and lateral thinking.

The technical tools and creativity techniques do not have inventive methodical specific. They can be used in all three problem area levels. Your choice is determined solely by the heuristic specifics of the respective work situation and the activities related to the situation.

3.1 The outcome matrix (ABER(1) matrix)

This is used to systematically record the target-determining

Requirements (**A**nforderungen)		Functionality
Conditions (**B**edingungen)	*related to*	Profitablity
Expectations (**E**rwartungen)		Controllability
Restrictions (**R**estriktionen)		Usefulness

of the technical system that is to be the subject of the innovation.

	Functionality	Profitablity	Controllability	Usefulness
A: Requirements				
B: Conditions				
E: Expectations				
R: Restrictions				

The *need for innovation* which is expressly or implicitly expressed in a technical-economic problem situation results, for example, from increased requirements, changed conditions, new expectations and tightened restrictions with regard to production, distribution, use, abrasion or removal of the technical system.

The ABER(1) matrix has 16 fields and contains at least as many outcome parameters as elements. It thus serves to systematically question the actual *need for action*, the *objective of action* and the *project idea* on which the innovation project is based, and converts these into technical-economic system properties of the technical product or service with direct reference to the corresponding process parameters.

Working with the ABER(1) matrix therefore also includes a process analysis going beyond the scope of the actual objective of the action. As result of this analysis the technical system with its overall function is delimited in the sense of a black box model and sufficiently defined with its interfaces in the overall process. It is important that no process level is skipped to capture also hidden facts, that not immediately trigger need for action and therefore are not mentioned in the action goal, but may cause additional problems.

This already may result in a *more precise definition of the action objective* and in a *modification of the project idea*, which can be decisive for the later invention. In the end the intention of the ABER matrix is to include all conceivable "yes, but" to anticipate, which would otherwise be opposed against an invention when it comes to putting it into production and introduce it to the market.

The heuristic goal of further work with the ABER(1) matrix is first to find out the technical-economic parameter that serves as *guiding figure* for the objective of the action according to variation as an independent variable, the variation behavior of the parameter system the target figure as a whole. In the further analysis of the complex target variable comes it is important to define the systemic, technical-economic problem that results from it this variation of the reference variable results.

The *technical-economic problem* is basically seen in the fact that the variation of the reference variable deteriorate other, high-ranking outcome parameters to an inadmissible degree or they cannot be complied with in terms of limit values.

Whether this problem can be solved within the framework of a professional design and dimensioning or whether the system-related limits of parameter optimization are exhausted here, i.e. whether there is a *need for innovation* in the sense of solving a TEC, can of course only be determined on the specific technical system. This can be an existing technical system in terms of the required overall function (reference variant) or one composed of components of the known and commercially available state of the art (basic variant). The advantage of a reference variant is that optimization algorithms as well as manufacturing and operational experience are available. The potential for error is therefore relatively small. But the potential for contradiction is high as the system as a whole may be out of date. It is the other way in the case with a basic variant. A decision goed usually for a basic variant with a balanced ratio of potential for error and contradiction.

3.2 The critical function matrix (ABER(2) matrix)

It serves to systematically delimit the critical functional area and to define the *technical-technological innovation goal* in the form of the ideal subsystem of the basic variant by defining

- the functional requirements,
- the design and manufacturing conditions,
- the technological influences as well
- the natural law restrictions and their fulfillment

in relation to the elementary components of the subsystem:

- *Operand* (object that is acted on),
- *Operation* (way of acting)

- *Operator* (means to act),
- *Counter-operation* (type and way of counter-action in the sense of creating a function-realizing equilibrium) and
- *Couter-operator* (means to stabilize the function).

This results in determining the *requirements for a technical-scientific solution* in terms of new functional requirements, other design and manufacturing conditions, changed technological influences or other types of natural law restrictions in the functional realization that are to be considered for which neither suitable means-effect relationships nor function-fulfilling technical arrangements are known in the system-related state of the art.

Working with the ABER(2) matrix is based on a *function-related structural analysis* of the system considered as a whole, to delimit the critical functional area and define the interface conditions for the *ideal subsystem* in both structural and functional direction. This makes the interrelations transparent and manipulable, which cause the *undesired effect* in the functional behavior of the ideal subsystem.

The ABER(2) matrix has 20 fields and at least as many functional or structural parameters as elements for the ideal subsystem. When it is created, the *need for innovation* and the *technical-technological innovation goal* are questioned. At the same time the *inventive innovation idea* is taking shape in the new functional principle of the ideal subsystem. The considerations extend beyond the ideal subsystem also to its interrelationships with the technical system as a whole. This is fixed in the definition of the design conditions and the technological influences in the ABER(2) matrix.

Working with the ABER(2) matrix does not only pursue to find the *contradiction-free inventive solution idea* for the ideal subsystem. The result also may be the formulation of a *technical-technological contradiction* (TTC) that prevents such a solution based on known principles of action. It is that the contradicting structural and functional parameters in the critical operational area of the ideal subsystem have been found and based on this, a solution strategy can be generated that is oriented on a new operating principle.

3.3 The matrix of the operational field (ABER(3) matrix)

It is based on a scientific-mathematical model and a working hypothesis based on that model concerning the processes in the critical operational area of the ideal subsystem. It serves to systematically record

- Requirements (A),
- Conditions (B),
- Findings (E),
- Restrictions (R)

in relation to

- technically usable *effects*,
- technologically to be controlled *side effects* and *accompanying effects*,
- constructively required *counter-effects* and *guiding effects* in the functional structure of the ideal subsystem

as well as the elaboration of the causal relationships between those operational field parameters.

The required *application-oriented scientific research effort* results from previously unrealized effectiveness and efficiency requirements, completely new usage conditions, not yet available scientific knowledge or ethical and ecological restrictions.

The operational field matrix has 12 fields and at least as many operational field parameters as elements to transform the problem and the *solution goal* from the technical to the natural science level of observation and representation. The problem remains unchanged the TTC. The solution goal now is the new function-fulfilling according to the solution strategy *operating principle*. The solution goal is therefore no longer immediately oriented towards the invention, but primarily towards the acquisition of scientific knowledge, which opens up new space for inventive thinking.

However, the operational field matrix also serves to critically question *inventive innovation ideas* and needs for technical-scientific solutions from natural science point of view. This can lead to a new view of the problem and a *new inventive innovation idea*, which no longer implies an undesirable effect and therefore is free of contradictions in the technical-technological meaning.

For the critical, solution-oriented questioning of the inventive innovation idea from this scientific point of view, the substance-field analysis (Wepol analysis) is suitable (ALTSCHULLER 1979). Within ProHEAL it was further developed from a more phenomenological to an analytical tool to create effect-related solution modules.

For this purpose, a *system of physical effects* in different forms was developed, most recently as a knowledge store on an electronic data carrier, that can be used to search for suitable solution variants or solution modules starting with a problem- and contradiction-oriented menu. Also Manfred v. Ardenne's monograph "Effects of Physics and their Application" published in 1988 was used in the inventor schools.

3.4 ProHEAL – tool for the engineer and inventor

The ABER matrix gives the open-minded observer many suggestions to have. So it is made by increasing parameters in one or more matrix fields Strived for and perhaps found inventive solutions. The open-minded one The observer had to do with the so-called basic variant, which he considered reason was. But soon the open-minded viewer can also look at obstacles and had reached the limits that prevented him from advancing. Then it got difficult.

The attempts to improve (increase) common parameter values of technical objects lead mostly approaches the situation in which the engineer has to pause to say: "Yes but what shouldn't happen?" That is a question of undesirable consequences. One objective of inventions is based on the most accurate knowledge of all possible "Yes but ...". It is to be striven to find for every "Yes but ..." not a "Either ... or", but an "As well ... as". The observing engineer feels now caught in a vicious circle. The "yes but ..." signals that there is a dialectical contradiction: Two tendencies are opposed to each other – battle of opposites – each tendency inevitably produces the other, often several others as well. The ABER matrix helps to perceive and understand what is happening. This is the starting point to determine the entries in the ABER matrix. What the designer refers to from the very beginning are the societal needs, the manufacturer needs, the user needs. A concrete objective must be derived from this. If no solution has been found for the contradiction after the first attempts, further questions about the basic variant must be asked and answered.

ProHEAL shows the way to a solution. The *mandatory target figure* (either completely specified or completed by the responsible engineer) is characterized in [P:(1.3)] as an expression of the identified system of ABER. The technical-economic parameters are to be derived from it. That some or many of them should be improving a lot (but none should deteriorate) is initially just a request or wish. They are rooted in the network of technical-technological or technical-scientific properties of the *basic variant* and are interlinked by these properties. From these connections in the ABER system inevitably result the "Yes, but", which are to be inventively transformed – through changes in the basic variant – in "as well as". In this inevitability lies the difficulty of a purposeful, effective invention.

The "yes but" become all the more delicate and acute,

- the more the effectiveness E is to be increased, because then limits of improvements based only on optimization of the technical object are reached or have to be crossed;
- the more consistently the target figure – the ABER system – is respected in its complexity so that improvements regarding some parameters no longer can be achieved by "cheap" approaches at the expense of deterioration in other parameters that one improperly ignored.

In the technical-economic development, such contradictions can be ignored for a while. It is possible

- if they are not serious in terms of their importance, because the parameters standing in contradictory relation are not serious in the overall system; in other words, if the complex target (the system of ABER) allows for a distinction between basic and less important parameters.
- if the contradiction is in the initial stage of development, where improvements of the parameters affect each other in a not yet excluding way. In this initial stage, a compromise solution can be found by optimization based on the state of the art which leads to a sufficient increase of value for each of the two parameters.

The method of invention must now evoke awareness,

- how the technical-economic contradiction to be resolved by analyzing the technical object – more precisely: the basic variant – is determined. Which relationships in the technical object are "responsible" for the conflict situation in the system of ABER? These primary, often complex relationships are usually not easily disentangled. More about the analysis up to the determination of the technical-economic contradiction see [P:sect. 1–4].
- how to find the point or secondary context hidden deeper in the technical object, in its structure where parameters can be changed in such a way that the primary context, on which the technical-economic contradiction is based, can be rendered harmless. This leads to the question about the technical-technological and possibly technical-scientific contradiction that must be uncovered when the technical-economic contradiction should be brought to disappearance. See [P:sect. 5–9].

3.5 The basic structure of ProHEAL

At the beginning the term a *guiding variable* GV has to be defined. The guiding variable is a system-specific parameter of central importance, the variation of which influences the development of the performance capability and/or the effectiveness of a technical system may be increased. In different words: Such increases are – mostly based on many years of experience – expected as a result of a variation in the guiding variable. The guiding variable can be, for example: the unit of performance of a large transformer or a large generator, the number of integrated curcuits of a microprocessor, the load level of a transport system, the starting torque of an electric motor (based on its nominal torque), the clock speed of a machine tool, the equilibrium concentration of a chemical process, the specific number of separation stages of an extraction process. More on this in [P:(2.3.4)].

A *technical-economic contradiction* (TEC) arises if in the variation of a technical parameter that is decisive for the achievement of this higher economic effect – the guiding variable GV – at least two important technical-economic parameters E_1 and E_2 of the technical object behave mutually opposite.

For example, consider the development of a container. As guiding variable GV we choose the thickness of the wall of the container in relation to its edge length. Reducing the thickness of the wall two essential technical-economic action parameters of the container are favourably influenced: the specific use of material, related to the container volume, and the payload ratio, i.e. the ratio of loadable mass to self mass of the container. We can therefore combine both parameters to the technical-economic action parameter E_1. The opposing technical-economic action parameter E_2 is the specific load capacity of the container, i.e. the loadable load in relation to the load level of the transport system in question. The latter becomes to low when the container wall thickness falls below a certain limit thus outweighing by far the economic advantages of material savings and the low weight of the container. In addition, slimming the wall thickness makes the container more susceptible to corrosion and mechanical damage. A further reduction in the specific wall thickness under a characteristic statistical limit value thus gives rise to a critical technical-economic contradiction.

A *technical-technological contradiction* (TTC) is given when during variation of the technical parameter that primarily determines the expression of the functional technical effect – the *structural value* SV – at least two decisive technical-technological action parameters T_1 and T_2 of the technical object become opposite to each other in their behavior.

In the example of the container with regard to overcoming the technical-economic contradiction we initially consider the container function as structural value SV. A functional technical effect is decisively influenced by it, namely the distribution of the load forces and the type of their effect (in the form of compression, tension, shear and/or bending stresses) in relation to the local strength distribution in the wall of the container. One of the essential effectiveness parameter of the container is based on this technical effect, its specific, i.e. related to its volume load capacity. We denote this with T_1. By suitably shaping the container wall the technical effect can be brought into effect in such a way that material savings and higher payload ratio no longer are in a technical-economic contradiction with the specific load capacity of the container.

If this does not succeed, we are faced with a TTC. It arises due to the fact that with the container shape as structural value SV not only the load-bearing capacity is significantly determined, but also the specific usable volume, i.e. the portion of the volume of the cargo container that can be filled and its accessibility, i.e. the way of loading and unloading the container. We can combine these properties to technical-technological effectiveness parameter T_2. The technical-technological contradiction can consist in the fact that a container shape is required to achieve a higher load-bearing capacity, that leads to a lower specific usable volume and/or less favorable way of loading or unloadability the container. This is the case, for example, when the container bottom should be given a curved shape to increase the load-bearing capacity and thereby the usable container height (when transporting bulky goods) or its unloadability (when transporting port of bulk goods) is inadmissibly impaired.

A *technical-scientific contradiction* (TSC) exists if, in the variation of a technical-scientific parameter that is decisive for the occurrence of a scientific effect, i.e. the *impact value* IV, at least two technical-scientific effectiveness parameters S_1 and S_2 of the technical object take values in opposite directions instead of the same direction as required.

Concerning the solution of the TTC in the case of the container we can, at least locally, consider the elasticity of the material of the container wall as effective variable IV. The impact of the natural law bound to this quantity is the elastic deformation of the container wall. This impact causes two essential technical-scientific effectiveness parameters to go in opposite directions:

- on the one hand, the adaptability of the shape of the container to the shape of the cargo and the adaptability of its strength distribution to the distribution of the specific load (S_1), but also
- on the other hand, the stability pf the form of the container (S_2).

Both effectiveness parameters will not contradict each other if the elasticity is appropriately distributed in the container wall or if the shape durability does not play a decisive role or is even undesirable. The latter is for example the case with the waste container. That's why the garbage bag is made of extremely thin, highly elastic shear and biodegradable plastic film. Choosing the impact value "elasticity" not only the TSC is solved, but also the TTC. At the same time the susceptibility to corrosion due to the extremely thin container wall is here even desirable because it results in rapid biodegradation of the container.

A TSC can be given, for example, if the negative influence of the selected impact value "elasticity" on the stability of the shape consists in that under dynamic loading vibrations of the container wall occur, which lead to resonance phenomena and as a result to an impairment of the load and/or to premature destruction of the container wall.

3.6 Surprisingly simple solutions (SSS)

The SSS are solutions with a particularly favorable ratio of effort and benefit. In [P:(6.4),(9.3)] we pay particular attention to solutions whose verbal description contains word like "by itself", "self-movement", "self-fixation" etc. Already [P:(2.14)] contains a question aimed at such solutions: "Which secondary functions in the system are suitable, to make other side effects usable or to avoid harmful side effects or to transform them into useful ones?" Very often such a suitability is given. Then a solution or partial solution of the type "by itself" can already be formulated during the very beginning of the system analysis, in this case a self-compensation.

Experience show that such simple and ideal solutions are mostly out of the field of vision. Therefore inventors rarely search for them.

Such solutions are characterized by the fact that their material realization can be reached predominantly with already existing functional units and energy potentials, with little equipment effort and/or little operating energy. In that sense they are simple, elegant, ideal. The technical world is full of such solutions from ancient times on, which unfortunately we are carelessly passing because we are using them from very childhood on. A typical example is the ship's anchor, an extremely simple device with pointed shovels that "by itself" all the more dig deeper into the ocean floor the stronger the wind or the waves attack the ship. The fishhook behaves analogously in the fish's mouth.

A similar example is provided by Duncker's pendulum, which addresses the problem of accuracy of a pendulum clock under temperature changes. But even in physics classes in schools such SSS that can be found en masse throughout the centuries of history of technology found are totally ignored. As a curious child I was surprised that the simple toilet cistern regulates the water supply automatically. So I asked my father, and because he was a craftsman, he explained it to me. Even G.S. Altshuller does not pay enough attention in his books to such surprisingly simple solutions. If you have never seen the opportunities, it becomes difficult.

3.7 The general heuristic path model of ProHEAL

W.1. The structure of the path model

The path model is shown in the figure as a heuristic scheme. It shows how from the technical-economic issues based on the necessary effectiveness and functional properties of technical objects, their structural and functional properties are derived and finally, it is abstracted to functional basics of technical-scientific effects and how to advance – progressing from abstraction level to abstraction level – on the search for solution ideas further and further away from the own specialist domain to distant analogy areas. Already here inventions with a high economic benefit can arise.

W.2. The social need and the ABER

From the more or less vaguely formulated technical-economic problem situation as starting point – according to the heuristic path model – are the social needs and the associated ABER to be determined. It is indispensable to detect the causes for the emergence of the social need and the ABER derived from it contrasting it with the current available state of technology and its past development. In this course it is always necessary also to check whether the given task is oriented to overcome the causes or only to eliminate undesirable economic, social, technical or ecological effects. During such an analysis the main technical-scientific problem to be solved can be delimited and a *reference variant* of the technical system can be determined that most closely matches the ABER.

Now in order to identify and weight the defects and shortcomings of the reference variant, to find the causes and to create an independent, "tailored" definition and solution of the specific problem, within a conceptual process of product planning first a *target figure* is determined. Along that target, from the ideal state of the art a representative *basic variant* of the technical system is created, identifying suitable technical means through patent research and analysis of world-class solutions and combining them to form the overall system. As part of a system analysis the basic variant is compared to the reference variant to find weak points and defects that lead to TEC in their behavior and are inventively to fix. From the basic variant a solution is to be developed that has clear technological and economic advantages compared to the reference variant.

W.3. The target figure and the state of the art

The ABER are initially available in a verbal-descriptive form and express social, economic and technological issues that affect a certain social situation of need and interests (see [P:sect. 1]). From this a target figure is to be derived, which essentially expresses the functional properties of the technical system to be created and in what way its production and application does meet the social need in the best way. This is done assigning to the components of the target figure the relevant ABER parts. This defines and evaluates concrete characteristics of suitability and effectiveness. On the one hand, these include the respective social, economic and/or technological specifics of the social need and on the other hand the objective specificity of the technical object or object area (see [P:(1.3)]).

These suitability and effectiveness characteristics must first be described qualitatively, before parameter values can be specified. A premature and uncritical commitment to functional or economic parameters that are familiar or mentioned in the task or even limiting oneself to them must be avoided.

In order to be able to define these parameters correctly, it is necessary to derive from the state of technology the most suitable *technical-technological principle* (TTP) for the technical object to be developed. That is a characteristic principle of manufacturing and/or applying technical objects in a specific technology domain. With this principle, a class of methods and means is delimited in the state of the art which represents the basis for further problem processing. Thus the choice of the TTP has decisive importance for the further solution. It should be done in such a way that such a TTP is preferred that fits the purpose of the technical object to be created (target component Z_1) in the best way and that does not conflict with the ABER or – in comparison to other principles – violates as less as possible A and E from the ABER system. For this, the following should first be considered all procedures and means

- that are *available* on the material state of the art,
- that *appear feasible* based on the ideal state-of-the-art, and finally
- that *seem conceivable* on the given state of technological development and that *seem imaginable* on the given state of sciences.

If a TTP is prescribed with the task, it has to be checked if it is feasible for the target figure and should be compared with other known principles. If necessary, this must be discussed with the client.

On the basis of the TTP, basic variants of the technical system are designed using the *methods and means available from the state of the art.* This is done transforming the target figure determined by the ABER in two stages:

In the *first transformation stage*, the types of technical objects are determined, which are *necessary* according to the TTP to ensure the suitability of the technical system with respect to the target figure. To every object type now such utility properties are attributed, which on the one hand are typical for the respective object type and on the other hand correspond to special suitability characteristics of the target figure. In doing so, it is appropriate first to determine the necessary contributions specific for that object type to the expediency of the system (component Z_1 of the target figure). Then those for the respective object type characteristic functional properties are defined that guarantee the suitability of the technical system with regard to its controllability and its usability. For a sufficient suitability of the technical system – especially with regard to its controllability – it can be necessary to take into account additional object types, that match such specific suitability characteristics with their functional or operational properties.

In this way, the target figure is transformed from a system of socially determined *suitability characteristics* into a system of object-related *functional properties*. This target figure is the basis for a systematic patent research and world status analysis for the pre-selection of suitable technical objects, which in their combination according to the TTP are sufficiently suitable to form a technical system that meets the ABER conditions.

In a *second transformation stage*, the *main function* of the technical system according to the TTP is defined. It can be assumed that the main function activates the functional properties of the individual objects and links them in the process of their use in such a way that the suitability characteristics of the technical system according to the ABER are produced. This main function breaks down, related to the usage process, in its *necessary and sufficient subfunctions*. Here, a hierarchy level of the technical system is selected that on the one hand is as high as possible, on the other hand takes into account the extraction of object types from the target figure that was already completed.

To the individual sub-functions such objects are assigned, that are activated by the respective sub-function in the sense of the main function of the technical system. For each sub-function, those functional properties are defined that are caused by these technical objects, which means that they define *specific technical means*. The sub-functions through which those object-related functional properties are activated that produce the suitability of the technical system concerning manageability and usability are established in the same way, however define *necessary supporting functions*.

In this way, the target figure is transformed from a *system of object-related functional properties* into a *system of process-related functional properties of technical means*. This target figuer is used for the appropriate selection of technical means from the set of technical objects take into account and their functional coupling constituting the basic variant of the technical system. Additionally, the target figure forms in this transformation stage together with the non-transformed component Z_2 (economic efficiency) the basis for the definition of the main technical-economic performance data of the technical system and for their quantitative determination in terms of a nominal figure.

The *system analysis* is based on this nominal figure. It is aimed at determining the effectiveness properties of the technical system in their combination, especially to uncover contradictory tendencies in their developmental behavior and to reveal the relevant technical causes in the context of a developmental weakness analysis. The function-related target figure can already provide an initial indication of the critical functional area (critical system area). This is usually the area where the greatest number of sub-functions meet in a technical object.

W.4. The basic variant

The technical means selected from the available state of the art according to the target figure are divided into *sub-systems in the form of separable structural units* based on their function. Each structural unit embodies one of the process-related sub-functions as part of the main function or a necessary auxiliary function that is responsible for control, protection and/or environmental compatibility of the system. With the functional combination of the technical means to sub-systems and the sub-systems to the overall system of the basic variant the ABER – the functional requirements (**A**nforderungen) and structural conditions (**B**edingungen) as well as the external influences (**E**inflüsse) and restrictions (**R**estriktionen) – it has to be taken into account how the individual technical means or subsystems exert influence on each other when combined to form the basic variant. To do this, for their coupling (by means of morphological scheme) a *ranking* has to be defined according to the technical-technological importance of the subsystems in such a way that a subsystem or technical means of higher rank defines the ABER for the subsystems or technical means on the respective lower levels of hierarchy.

W.5. The decisive defect and the core variant

The basic variant developed according to the state of the art or the technical sciences still have decisive deficiencies. These deficiencies can be of technical-economic nature, arising from the fact that the utility and economic properties could not be brought into agreement with the target figure, i.e. requirements and/or restrictions had to be violated. The defects can also of "heuristic" nature, e.g. if means are neither available nor feasible, but at most conceivable or even only imaginable.

A *technical-economic deficiency* is present if the technical means required according to the target figure are principally available or known, but at least in a crucial functional property the required performance and/or effectiveness parameters are not achievable or only at the expense of other evaluation parameters.

A *heuristic deficiency* is present if for at least one of the functional properties required by the ABER no technical means are known which would be suitable according to their functional properties to produce the required means-effect relationships. To become aware of a heuristic deficiency requires inventive instinct and courage to work since conventional and proven technology has to be questioned.

For further problem processing, that basic variant is selected which has the smallest deficiencies. An inventive approach is characterized by the property that it does not allow any serious technical-economic deficiencies, but deliberately accepts serious heuristic deficiencies when they challenge for inventive solutions. If there is a serious heuristic deficiency the subsystem or system area where the deficiency appears is declared as the decisive subsystem or the *core variant* of the technical system. For the problematic core of the basic variant in this subsystem or system area new, conceivable solutions are generated by new modifications or previously unusual combinations of known technical objects. From these core variants, the one is chosen that does best fit into the overall context of the technical system of the basic variant. This may already be an inventive solution and is then the result of a heuristic approach, which can be described as *projecting invention.*

If the basic variant consists of an inventive core variant with only low technological scope and in the remainder of verified and tested system components according to the available state of the art, and does not show significant deficiencies in relation to the target figure, it can be optimized, transferred into an overall operational project and tested in a pilot series or trial production.

However, if there are still considerable deviations between the utility value and the effectiveness of the basic variant on the one hand and the target figure on the other, and in particular the functional characteristics of the core variant in the overall context of the technical system are still in question, then the further procedure is aimed at identifying the causes of these deficiencies more precisely and to investigate and fix them. For this purpose, first of all, a *technical-economic objective* is derived from the target figure as more precise specification, which is aimed at the increase of those performance and/or economic parameters (main performance data), the fulfillment of which is still in question.

W.6. The structurally prepared basic variant

The cause of the deficiencies is initially searched for in the structure of the technical system. For this purpose, the basic variant is structured according to its structure abstracting from functional properties of individual objects or groups of objects to structural properties of the technical system. This is done in such a way that the technical objects combined and functionally linked in the basic variant are considered with regard to their necessary structural properties (mainly contained in the target components *controllability* and *usability*) and are coordinated in such a way that they can be spatially and/or temporally combined to form the structural units and the overall system of the basic variant.

This creates the system-specific structural properties of the technical means. Here, above all, the structural properties in the system area of the core variant are emphasized that primarily influence the specific performance and/or economic parameters of the technical-economic objective. A variation of the structural properties of the technical system in the sense of the technical-economic objectives often results in a deterioration in specific functional properties that already highlightes a technical-economic contradiction.

In many cases this is a conflict between the requirements of manufacturability, mountability and/or maintainability (or the continuous process management, the monitorability and controllability of procedures) and the requirements of functionality, insensitivity to external disturbances and internal functional security.

Here the inventive processing is initially aimed to find the critical structural unit or functional weak point that primarily prohibits an optimal design and dimensioning of the basic variant. By a clever transformation or redesign of one or more objects within this critical system area the functional performance can be increased without changing the function itself. If this succeeds, then an inventive solution of the contradiction between structural and functional properties of the basic variant has been found in the sense of the technical-economic objective. Such an approach is called *constructive invention.* The inventive solution has initially to be transferred into a functional model and to be test for its functionality.

If it turns out that the technical-economic objective cannot be met, if functions are not changed, the basic variant has to be prepared concerning its functional fulfillment and a corresponding system analysis is required.

W.7. The preparation of the basic variant cncerning its functional fulfillment

In the functional preparation of the basic variant, the structural properties of technical objects is abstracted to their functional properties. The aim is to *identify the essential functional relationships* of the basic variant as technical system with its environment, and which internal functional relationships (means-effect relationships) between its components are decisive for that.

First of all, on has to determine the overall function of the basic variant and its known or foreseeable side effects as well as the interface conditions to its technical-technological environment. This is done by a *black box analysis.* The interface conditions (boundary conditions) of the black box define the input variables of the technical system from the specified output variables of a preceding system within a higher-level process, and its output variables from the specified input variables of a following system at the same higher level. Depending on the type of input and output variables from this results the transfer or support function mainly to be implemented by the basic variant as a technical system. This is therefore defined as the *main function.*

However, this does *not* happen process-related – as with the transformation of the target figure – process-related, but object-related. That is, the function is not considered as necessary, process-related activation of certain functional properties of technical objects, but as *structurally constrained effect of certain functional properties of technical means.* After that the necessary technical prerequisites for the creation and maintenance of the main function, i.e. for the functioning of the technical system, are determined. From this the required auxiliary functions are defined, concerning the types *interference suppression function* and *protection function.*

Defining the *interference suppression function*, one can first refer to the functional properties that are contained in the target component Z_3 (controllability). In addition, it is necessary to determine what side effects are triggered from the specific objects of the basic variant during operation or use. These side effects must be recorded as completely as possible. There are harmful as well as useful or usable side effects. Necessary measures to suppress the harmful side effects caused by the overall function to acceptable levels lead to the definition of the interference suppression function.

Necessary measures to suppress harmful effects caused on the main function and the interference suppression function of the technical system by the environment, lead to the definition of the *protection function* of the system. Defining the protection function we can initially be conducted by the usage properties and usage conditions, which are combined in the target component Z_4 (usability). Concerning the harmful effects from the environment not only technical, technological and natural ones are to be considered, but possibly also social (qualification, discipline) and organizational (supply of means of transport, material, energy and/or information) are to be taken into account.

An important for the inventor functional class are the *auxiliary functions.* This are functions, which are generated "for free" by the objects of the basic variant in addition to their main functional destination. They have to be investigated whether and to what extent they can used to support or even to replace functions of one or more other objects of the basic variant. This can lead to a *fusion of functions*, the effect of which goes beyond the sum of the individual effects of the objects in question. This is an important indicator for an inventive achievement.

Auxillary functions that cannot be used are considered as *unnecessary functions*. They should be eliminated as completely as possible by a more suitable choice or design of the objects of the basic variant, at least when they provoke a disruption of the functional flow of value or cause unnecessary costs.

For a complete recording and advantageous design of all interrelationships between the system and its environment, it is necessary to delimit an *operational field* for the inventor in relation to the technical system. It includes all objects – technical and natural – as well as all factors – social, organizational and technological – with their harmful and beneficial effects that the technical system with its function has to take into account or that can be effectively included in its function. It depends on the correct delimitation of the operational field and the technical system whether the protection function is correctly determined and whether objectively available options to simplify functions or to increase function value are recognized and used for improvements. (See [P:sect. 3]).

Depending on the situation, this can be done in such a way that suitable objects from the operational field are used to support or simplify functions including them in the basic variant by structural as well as functional integration assigning them an adaptation function. Conversely, it can also prove to be advantageous, and in some cases even necessary to relocate certain objects from the basic variant to the outer part of the operational field. A close functional and structural link across the system boundaries in the sense of a mediation function can generate a positive influencing factor in the outer operating field or reinforce an existing one. Possibly one gets thereby at the same time a simplification of the function of the basic variant or an increase in their functional value.

With the black box analysis of the basic variant, its function-related processing is essentially completed. The knowledge gained about the functional characteristics of the basic variant, their mutual dependencies and the possibilities to optimally coordinate them with each other and with the system environment are now used to attempt to resolve the contradiction between structural and functional properties that occurred during the structure-related preparation of the basic variant. Here you can in an inventive way, through an original distribution of the required functions to the individual objects of the basic variant and the skillful use of so far neglected structural and functional properties create the prerequisites for an optimal overall solution.

W.8. The optimization of the basic variant compared to the reference variant and the TEC

In order to be able to optimize the basic variant, a technical performance parameters has to be determined as a *guiding variable*, the variation of which affects to a decisive extent on the one hand the effectivity parameters of the technical-economic objective and, on the other hand, the necessary structural and functional properties of the technical system. Choosing the guiding variable, we decide the direction of the further development of the technical system and the development trend of its utility and economic efficiency properties.

The guiding variable must therefore be in agreement with the target figure, even if it turns out that its variation – although professionally thought ahead – leads to changes in the structural and functional properties of the technical system, which (at least partially) are still in contradiction to the technical-economic objectives. As orientation for the correct determination of the guiding variable can serve the reference variant which was derived from the worldwide material state of the art.

As guiding variable serves the technical performance parameter in which the reference variant still deviates at most from the target figure. That is, the requested performance (in the target component Z_1) is achieved either not at all or under the given implementation conditions only with impermissibly high technical (Z_3), technological (Z_4) and/or economic effort (Z_2). This way, a follow-up strategy is prohibited from the beginning and a progressive solution strategy is designed that meets real social needs.

In addition, the reference variant can be included in the black box analysis as a suggestion for the functional and structural conceptualizsation of the basic variant. Did we already succeed – possibly in an inventive way – to develop a basic concept that can be optimized then we will find an optimal overall solution for the basic variant that meets the technical-economic objective through well-coordinated design and dimensioning of the individual objects. If it is found, then the functionality and the functional value of the basic variant has to be tested on a test sample. For this, it is sufficient to reconstruct that part of the functional area of the basic variant, in which the decisive structural and functional changes are located that were carried out compared to the tried and tested state of the art. As a rule, it is the core variant and its closer system environment.

If an optimal overall solution has not yet been found or if the design of the basic variant proves to be not functional, the decisive TEC is be to determined. In other words, the decisive technical-economic effectiveness parameters have to be determined that relate to one another in such a way that the increase in one parameter leads to an impermissible reduction of the other parameter, if the guiding variable is varied according to the technical-economic objective (see [P:sect. 4]).

The further procedure is now no longer possible through *accompanying* or tactical inventing, but characterized by *forward-looking*, strategic invention. It is actually inventing the true meaning of the method, the *invention itself.* This brings us to stage 2 of the organizational model, at the beginning of which a *renewal pass* and a *specification sheet* with a clear inventive task hav to be negotiated. The subject of the invention is now a technical-economic contradiction, the goal is to overcome it.

W.9. The inventive core variant (key variant)

When overcoming the TEC, it is assumed that its cause is not distributed around the whole technical system, but essentially focused in a specific system area – the area that is critical for the functioning of the technical system, the *critical functional area.* The inventive goal now is to *discover* this system area and to produce an inventive solution, that creates in this critical area new technical conditions, new means-effect relationships, opening new possibilities for the development of the basic variant and the corresponding variation of the guiding variable in terms of the technical-economic objective.

W.10. The critical functional area of the basic variant and the ABER

Based on the result of the black box analysis, the findings during the unsuccessful optimization of the basic variant and possibly from a functional that was completed with testing negative result, the causes of the technical-economic contradiction are to be explored. (See [P:sect. 5]).

For this purpose, continuing the black box analysis the basic variant is first divided into the object-related sub-functions, which are essential for a working chain of intended and/or to be prevented *changes in state of one or more objects* that produces in the end a stable and effective main function. For the specification of the necessary functional features one can exploit the usage properties that are summarized in the target component Z_1 (Expediency) in terms of effects of their activation. Thus one can assign system components contained in the basic variant as objects to individual sub-functions and assess them with regard to their functional value.

It will always be possible to delimit an area of the technical system in which one or several sub-functions are present, which in comparison to the neighboring system areas have a significantly lower functional value. This system area acts like a bottleneck in the function value flow of the main function, which this and other sub-functions does not take full effect and thus decisively limits the overall functionality of the technical system. It is therefore called *critical functional area* of the technical system.

For the inventor, it is not only the question of the technical-scientific causes for the emergence of the functional bottleneck, but also the question of the *technical-constructive or operational-procedural reasons* that prevent the elimination of these causes in the way to an optimal dimensioning. These reasons are to be reduced to a *harmful technical effect* (HTE), which prevents the development of the technical system according to the target figure.

The answer to this question about the HTE, which is crucial for the inventional task, can only be derived gradually. For this purpose, the sub-functions created in the critical functional area are divided according to their procedural principle into *elementary functions* and corresponding, objective *functional units*. The individual functional units are resolved into their operational components – *operation*, *operand*, *operator* and *counter-operator* – and according to the functional principle of the respective functional unit technically defined as functional parameter. In this way the critical functional area can be clearly and transparently displayed in a morphological scheme.

The *function value flow* is now examined from elementary function to elementary function. In doing so, following a suitably selected guide variable (structural variable), an optimization of the functional units is attempted to implement varying the functional determinants while keeping the principle of operation.

Depending on the result of these optimization attempts, the root of the harmful technical effect may be limited on certain functional units and their structural and functional properties. This means that the critical functional area is increasingly narrowed and more precisely defined. At the same time, the technical and natural law requirements, constraints, influences and restrictions (the ABER) are determined in their specific for the technical system form of interrelation that determines the technical-scientific core of the problem.

That is, the further set of ABER defined at the beginning of [P:(2.4)] become a system linking the sub-objects of the basic variant. This ABER on technical-scientific level is the analogue of the ABER on the technical-economic level. Note that at this level, we work as **E** with *influences* rather than *expectations*.

These new ABER prevent to overcome the TEC. These ABER are to be changed in a following stage of the inventive process in the sense of a technical ideal (IDEAL) in such a way that the HTE disappears. In that process it is initially not allowed to vary technical product requirements or restrictions by natural laws.

W.11. The harmful technical effect and the IDEAL

The (technical) IDEAL primarily refers to the behavior of the technical system in its critical functional area. The rest of the technical system is initially essentially set immutable. With the IDEAL, such ideal constructive conditions and/or such ideal procedural arrangements are thought ahead the recognized optimization limits, that all undesirable technical-scientific influencing factors disappear or are at least reduced so far in their effect that a decisive increase of the functional value in the critical functional area appears. The functional principle or the operational principle are initially not changed. (See [P:sect. 6]).

In contrast to the technical-economic ABER the technical-scientific ABER are not directly derived from the social supersystem and the technological environment of the technical system, but rather from its constructive or procedural structure and the functional principle implemented there. With these ABER next to *requirements*, *conditions* and *restrictions* also *influences* (in the sense of side effects) of technical-constructive and technical-scientific type are recorded, which the components of the technical system exert on each other, or which affect them from the system environment.

Opposing new conditions and pushing back the influencing factors has to respect technical requirements for structural and functional basic properties of the basic variant and must not violate natural law restrictions, which are set by the overall function of the basic variant in a principal way. Otherwise the IDEAL will cause another harmful technical effect in another system area, which usually also leads to a specific TEC.

Should it turn out that the elimination of a harmful technical effect is only possible with the emergence of another one, so in every case it is to "scout" whether there is one of these harmful consequential effects, against which a supplementary IDEAL may be thought that meets all the requirements and restrictions of the technical system. As a rule, however, this requires a detailed examination of the structural and functional interrelationships of the technical system – at least in the environment of the critical functional area.

In order to avoid an odyssey through the technical system, this exploratory procedure therefore only makes sense as long as it does not go too far beyond the originally delimited system. If such an IDEAL approach is found that can be developed futher, a stable *technical effect* (TE) and a mediating *functional principle* (FP) has to be searched which correspond to the new conditions and influencing factors in the system of technical-scientific ABER. This is the starting point to develop the *sub-function principles* and the *technical principle* of the inventive solution for the core variant (key variant) that can be tested in a test sample.

However, if no viable IDEAL approach has been found, so the further process starts with the approach that is in greatest compliance with the requirements and restrictions in the system of scientific ABER. The findings from the exploration of the technical system are now summarized as the technical-technological contradiction (TTC) summarized. (See [P:sect. 7]).

W.12. The technical-technological contradiction (TTC) and the new functionals principle for the key variant

The TTC defines the specific technical issue that the removal of the initially found harmful technical effect *necessarily* yields another, just as difficult to remove harmful effect. To resolve this contradiction now the *general problem-solving principles* are brought into consideration. (See [P:sect. 9]).

If a solution has been found to overcome the TTC, it is first to be checked its *technical effect* at IDEAL for its fundamental usability. Then the technical-scientific ABER are to be modify accordingly, and it is important to ensure that this does not violate technical requirements or scientific restrictions. Finally, it must be checked whether the *harmful technical effect* has actually been eliminated and no new TTC has been created. Only then it time to define – with reference to the IDEAL – a more detailed specification of the *new technical effect* and the system-compatible expression of the *new functional principle* for the key variant.

If a usable approach to solving the TTC is not found, the technical-scientific fact is to be determined, which decisively opposes this solution. For this purpose, the system analysis is directed to the critical point of action of the key variant, where those technical-scientific restrictions start that are decisively involved in the creation of the TTC. Theis from the critical point of action emanating technical-scientific restriction is called a *harmful scientific effect* (HSE). It essentially consists in the fact that the functional principle of a functional or utility value-determining technical partial effect which should be evoked at the critical point of action prohibits certain functional and/or structural changes in the vicinity of this point of action. (See also [P:sect. 7]).

W.13. The technical-scientific contradiction (TSC) and the new operational principle for the key variant

In a *database of scientific effects and principles*, such approaches are searched for that produce the necessary technical partial effect at the critical point of action in at least the same strength but the original scientific restriction is no more relevant.

Of course, it must always be checked whether only a problematic restriction has been exchanged against another. This examination can initially be done on a theoretical basis of a technical-scientific model of the point of action and its immediate surrounding. In this process the elementary (functional and structural) conditions and relationships have to be investigated that are required to create the necessary conditions for the appearance of the new technical partial effect at the point of action. It always turns out that at least one of these conditions must be met without restriction due to the selected operating principle. That is, it is to be regarded as the *new natural law restriction.*

To determine whether or not this new restriction prevents solving the problem it can be compared with the IDEAL within the system context of the technical-scientific ABER and examined whether the harmful technical effect is now eliminated or the TTC can be solved. If this is the case, starting from the IDEAL a *specification of the new technical effect* and the system-compatible *expression of the new functional principle* for the key variant are to be developed.

However, before the partial function principles and the technical principle are developed from this, the simplifying assumptions and the neglected possible secondary effects and subordinate influencing factors of the *technical-scientific model* have experimentally to be checked on validity and reliability. A *laboratory sample* is used for this, i.e. a replica of the structure of the technical system in the area of the critical point of action.

If, even after several approaches, a suitable technical-scientific principle of action for the solution of the TTC is *not* found, the knowledge gained is expressed as *technical-scientific contradiction* (TSC). This justifies the problem-specific scientific fact that for the technical system of the basic variant *there is no operational principle*, that removes a technical-scientific restriction without causing other equally serious ones. The reason for this are *restrictive functional and/or structural conditions and requirements* of the technical system that do not allow new operating principles to develop either.

With the help of the *general problem-solving principles* an attempt is now made to meet to "weaken" these conditions and requirements in such a way that one of the considered operational principles no longer leads to a TSC. This means that also the TTC and the TEC are also solvable in principle. (See [P:sect. 9]).

4 PROHeal – the Algorithm

The information in brackets refers to the points in the handout ...

A. Technical-economic Part of the Program

Objective: Critique of the state of the art from a technical-economical point of view. Determine the relevant target and reference variables.

(A1) Specify the societal need (SN) according to operational tasks of the enterprise (OTE) including

- (A1a) Determine the overall SN (1.3), (1.6)
- (A1b) Determine the special SN (1.1), (1.2), (1.4)

(A2) Find the ABER (1.4), (1.6), (1.7)
(A3) Determine the required use properties (1.4), (1.5)
(A4) Define the components Z_i of the target variable ζ (1.8), (1.9), (1.10)
(A5) Choose the technical-technological principle (2.1)
(A6) Determine the basic variant of the technical system starting from the state of the art (2.2), (2.3), (2.4)
(A7) Formulate the technical-economic objective (2.5), (4.3b)
(A8) Black box analysis of the technical system (2.6), (2.7), (2.8), (2.9), (2.10), (2.11), (2.14), (2.15), (3.4)
(A9) Delimit the technical-economic field of operation (2.12), (2.13), (3.1), (3.2), (3.3)
(A10) Determine the lead variable G_F (2.5f), (4.1)
(E1) **Decide:** Is the technical system appropriately delimited? (4.2), (3.4)

- **Yes:** Go to (E2)
- **No:** Back to (A8)

(E2) **Decide:** Is an optimization solution possible? (2.9), (2.14), (2.15)

- **Yes:** Work out the optimization solution → **STOP**
- **No:** Go to (A11)

(A11) Find and formulate the technical-economic contradiction that determines the problem (4.2), (4.3), (4.4)

(E3) **Decide:** Is there a case of "Business blindness"?

- **Yes:** Back to (E2)
- **No:** Proceed with part B
- **Unknown:** Back to (A5)

B. Technical-technological Part of the Program

Objective: Critique of the state of the art from a technical-technological point of view. Determine the decisive operation parameters.

(B1) Find and formulate the undesired effect (2.10), (2.11), (2.15c), (2.15e), (5.1), (5.4)

(B2) Delimit the critical functional area in the structure of the technical system (2.8), (2.15c), (2.15d) (3.4), (5.2), (5.3)

(B3) Draft the ideal vision for the core variant (in the critical functional area of the technical system) – IDEAL – (6.1)

(B4) Develop ideas about the necessary technical requirements (ABER) for the usefulness of the ideal image (ideal conceptions) (6.2)

(B5) Conceptual modification of the technical system with regard to required functional properties outside the critical functional area according to the ideal vision on the ABER (6.3), (6.4)

(E4) **Decide:** Will a harmful technical effect reappear? (6.5)

- **Yes:** Back to (B2)
- **No:** Go to (E5)

(E5) **Decide:** Are the ABER sufficiently determined? (6.2a)

- **Yes:** Go to (B6)
- **No:** Back to (B4)

(B6) Exgtract the ideal final result (IFR) (6.4)

(E6) **Decide:** Is the ideal vision in the ABER technically feasible? (6.2a), (9.5)

- **Yes:** An unexpected approach to a **surprisingly simple solution** (SSS) is found (6.5). Back to (E2).
- **No:** Go to (B7)

(B7) Find and formulate the technical contradiction (6.2d), (7)

(E7) **Decide:** Is it a prejudice of the professional world? (6.2a), (9.5)

- **Yes:** Transition to the elimination of a technical contradiction with surprising impact (6.2a), (9.5). Back to (E2).
- **No:** Go to part C
- **Unknown:** Back to (B1)

C. Technical-scientific Part of the Program

Objective: Critique of the state of the art from a technical-scientific point of view. Determination of the decisive effective variables.

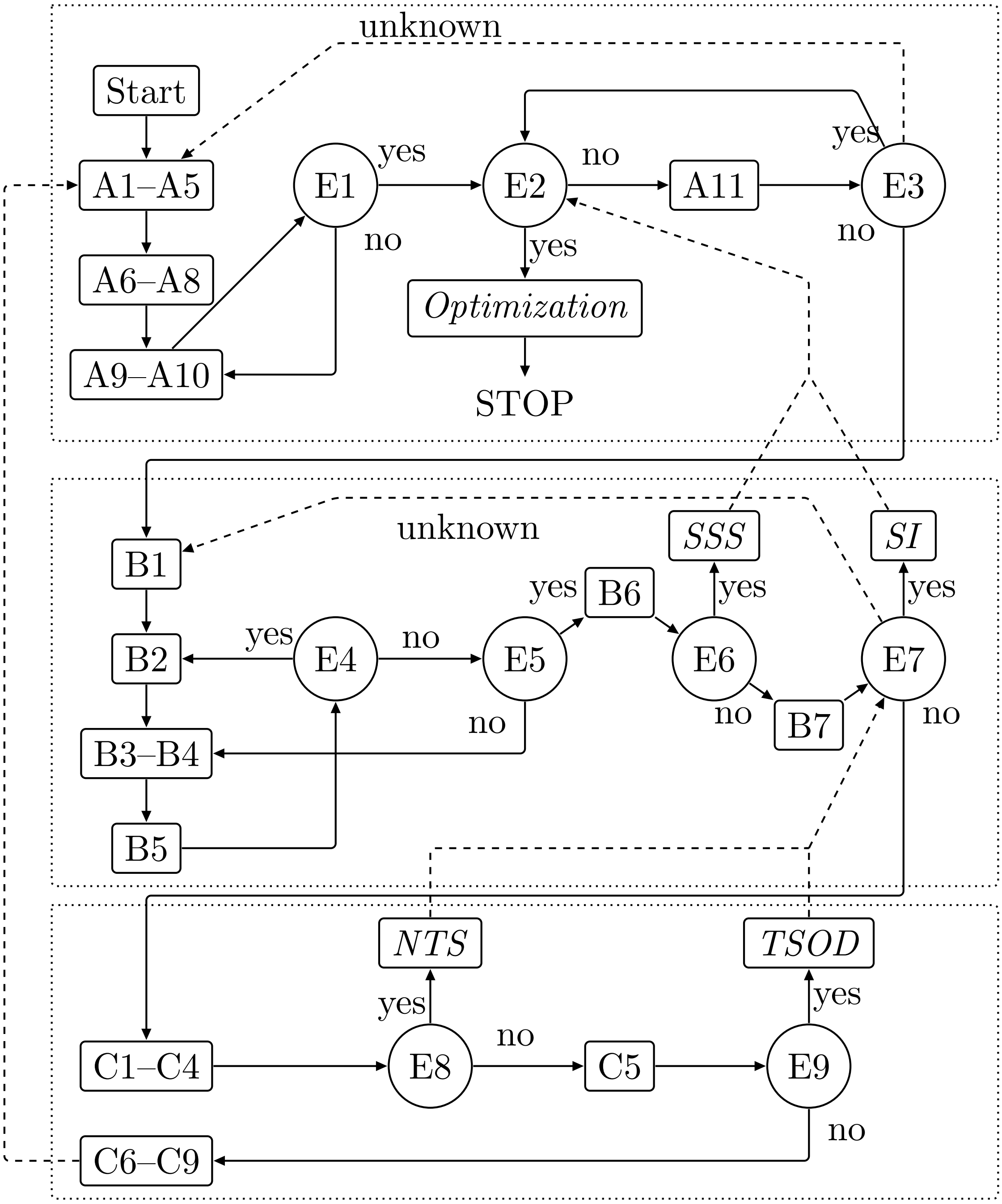
(C1) Derive the technical-scientific cause of the harmful technical effect from the ideal vision of the ABER (8.1a)
(C2) Limit the area of the critical point of action in the technical system (2.8)
(C3) Model the critical point of action
(C4) Formulate a search query to the database of scientific effects to realize the ABER according to the ideal vision (ideal scientific effect) (8.3)
(E8) **Decide:** Is there an appripriate scientific effect?

- **Yes:** Consider it as basis for a new technical approaches. Back to (E6).
- **No:** Go to (C5)

(C5) Formulate the technical-scientific contradiction (8.1b), (10.1)
(E9) **Decide:** Is it a matter of blindness in the professional world? (8.2), (10.1)

- **Yes:** Consider these technical approaches from a foreign domain. Back to (E2).
- **No:** Go to (C6)
- **Unknown:** Back to (C1)

(C6) Find suitable solution strategies in the technical system to overcome the technical contradiction (8.2), (9.1), (9.2), (9.4a), (10.2)
(C7) Formulate the inventional task with the goal of a radical renewal of the structure of the technical system (9.4b)
(C8) Find suitable solution principles to solve the problem of the inventional task (9.3), (9.4a)
(C9) Find fundamentally new approaches to solutions (creation of a new generation of the technical system) (10.2) → **Back to (A5)**



Legende

SSS	Surprisingly simple solution
SI	Surprising impact
NTS	Novel technical solution
TSOD	Technical solution from other domain

5 German-English Translations of Terms

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