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Entrepreneurship Education, Project Management Learning and Heuristics

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Abstract:

What's special about project management learning is, that this medium can be applied to all levels in the context of Entrepreneurship Education and can promote both the development of "transferable skills" and "specific skills". Hereinafter the focus will be on „transferable skills" in the form of heuristics. In project management various heuristics are used simultaneously without necessarily being always made explicit. They are a rather implicit part of the methods and strategies applied. In this report five Project Management Heuristics will be exemplary presented as possible learning outcomes of a Entrepreneruship Education based on Project Management Learning.

Zusammenfassung:

Das Besondere des projektmanagement-basierten Lernens ist, dass dieses Medium auf allen Ebenen im Rahmen einer Entrepreneurship Education zum Einsatz kommen kann und die Entwicklung von sowohl „transferable skills" als auch „specific skills" unterstützen kann. Der Fokus in diesem Forschungsbericht liegt auf den „transferable skills" in Form von Heuristiken. Im Projektmanagement (PM) finden verschiedene Heuristiken Anwendung, ohne dass diese immer expliziert wären; sie sind vielmehr implizierter Bestandteil der von Projektmanagern angewendeten Methoden, Instrumente und Vorgehensweisen. In diesem Beitrag werden fünf PM-Heuristiken als mögliche Lernergebnisse einer projektmanagement-basierten Entrepreneurship Education vorgestellt.

1 Introduction

In the report "Entrepreneurship in Vocational Education and Training" a program must meet at least two of the following points to qualify as entrepreneurship education: „Developing those personal attributes and generally applicable (horizontal) skills that form the basis of an entrepreneurial mindset and behaviour; Raising students' awareness of self-employment and entrepreneurship as possible career options; Work on practical enterprise projects and activities, for instance students running minicompanies; Providing specific business skills and knowledge of how to start and successfully run a company." (European Commission, p. 10). These four aspects can be divided into two groups. Because of their difference in nature we propose to distinguish these groups conceptually:

(1) Entrepreneurial Education
- Entrepreneurial mindset and behaviour: Developing those personal attributes and generally applicable (horizontal) skills that form the basis of an entrepreneurial mindset and behaviour.
- Entrepreneurial pratice and experience: Work on practical enterprise projects and activities, for instance students running minicompanies.

(2) Education for Entrepreneurship
- Awareness of Entrepreneurship: Raising students' awareness of self-employment and entrepreneurship as possible career options.
- Entrepreneurship in practice: Providing specific business skills and knowledge of how to start and successfully run a company.

On the one hand, Entrepreneurship Education is the basis for building an Education for Entrepreneurship. On the other hand, the learning outcomes of Entrepreneurship Education can also be viewed independently of any Education for Entrepreneurship: The here acquired skills and abilities are then also usable if there is no intention to set up an own business (such as intrapreneurs).

Likewise, Neck and Greene (2011) distinguish four basic forms of mediation or four perspectives of Entrepreneurship Education:

(1) Cognition: In this form of mediation the person, entrepreneurs and their mindset is the focus and not their personal attributes. The students here will learn, e.g. by means of case studies, how entrepreneurs think and how entrepreneurs decide.
(2) Method: In this form of mediation personal experience is in focus, the collecting experiences and the circumstanced entrepreneurial action. Methodically, role play, simulation or training companies can be used.
(3) Entrepreneur: In this form of mediation the entrepreneur is seen as a "Hero" with ideal attributes and behaviours. Learning is initiated here from the contrast between the student's self-concept, and the ideal entrepreneur's role model. A central method here is the contrasting self - and external assessment.
(4) Process: In this form of mediation it is not the person "Entrepreneur" that is in focus, but specific processes, such as the process of founding a company. Here, the students learn key processes such as business planning that they should replicate.

The two classifications are combined in our four-level model for Entrepreneurship Education (see table below).

Focus & Level			European Commission	Neck & Greene	
„Education for Entre-preneur-ship“ with the focus on specific Skills	4	Entrepreneur -ship in practice	Providing specific business skills and knowledge of how to start and successfully run a company.	Process	Business Planning
	3	Awareness of Entrepreneur ship	Raising students' awareness of self-employment and entrepreneurship as possible career options.	The Entre-preneur	Self - and external assessment
“Entre-preneurial Education“ with the focus on transfer-able skills	2	Entrepre-neurial practice and experience	Work on practical enterprise projects and activities, for instance students running minicompanies.	Method	Role-play, Simulation, Practice Company
	1	Entrepre-neurial mindset and behaviour	Developing those personal attributes and generally applicable (horizontal) skills that form the basis of an entrepreneurial mindset and behaviour.	Cognition	Case Studies

Table 1: Four-Level Model of Entrepreneurship Education

The Four-level model helps to detect blind spots or to situate approaches: Fretschner and Weber (2013) distinguish, for example on the basis of Liñán (2007), two basic forms: (1) "awareness courses aiming at sensitising" and (2) "action-oriented start-up courses seeking for qualifying". For awareness courses with focus on "mindsets, attitudes and desirability" (Fretschner and Weber, 2013, 412) the authors see the following content as appropriate: “knowledge in fundamentals like entrepreneurs' role in the society and economy, phases of the entrepreneurial process, entrepreneurs' tasks and challenges in the start-up phase, typical critical incidents, and crucial abilities and key competencies used by entrepreneurs.“ (Fretschner and Weber, 2013, 412.) For action-oriented courses seeking for qualifying and preparing students to be the owner of small business, according to the authors the following content is seen as appropriate: "e.g., business planning, strategy formulation, market analysis, how to obtain financing, legal regulations, and taxation" (Fretschner and Weber, 2013, 413).

According to our four-level model, the authors focus a mixture of levels 1 and 3 (mindset, attitudes, desirability & awareness) on the one hand as well as level 4 (start-up) on the other hand. In contrast to this approach, we propose to distinguish between a basic education (Entrepreneurial Education) and a specialised further development education (Entrepreneurship Education). While basic education should begin in elementary school as well as being offered in the general secondary education system as well as the vocational education system, the specialised further development education should in our opinion be offered at the earliest from the upper secondary level beginning with level 3. Level 4, in our opinion makes sense to be considered in vocational education and training and at University level.

Project Management Learning and Entrepreneurship Education

What's special about project management learning is, that this medium can be applied to all levels (1 to 4) and to grade levels in the context of Entrepreneurship Education.

Project management learning can be both be applied for the development of "transferable skills" (RPIC-ViP, 2011) as well as the development of "specific skills". In a project students can, for example, develop "transferable skills" (level 1 and level 2) in the form of "cooperation and communication skills", in the form of abilities "to think ahead", "to develop creative solutions", "to take the initiative", "to be flexible in reacting to problems" and "to reflect critically on their own actions and their consequences". Apart from that, in a project students can develop "specific skills" (level 3 and level 4), e.g. in the planning and realisation of founding a company. The founding of a company should be a project that is planned and implemented logically.

The scale is in accordance to the required level through the instrument "Project Management". Scaling is on the one hand through the dimension of "Autonomy or support from the teacher", as well as on the other hand the "Scope of project management methods used or the project management professionalism".

Scope of Auto-nomy	high				Professional PM Methods
	fairly high			Advanced PM Methods	
	fairly low		Simple PM Methods		
	low	PM by the Teacher			
		low	fairly low	fairly high	high
		Scope of the PM Methods (from the point of view of the student or the student's)			

Table 2: Scaling the Project Management Aspiration Level

"Simple", "advanced" and "professional" are relative terms related to a reference. If the reference is changed, the classification changes. The aspiration level for the level of "Professional PM Methods" is aligned with the level of project management professional training, as offered by the GPM (German Association for Project Management). This training specifically focuses on the further training of working professionals in the context of their work who either manage projects themselves or who participate in project work. The training consists of 10 days spread over approximately 4 months and includes a standardised final exam. The level of education corresponds to internationally known as "level D" of the International Project Management Association. International level C, B and A can only be achieved if project management is applied as a professional activity in a work context. Level D or the Project Management Professional is the highest level achievable within the framework of educational training. Below this level, the GPM (German Association for Project Management) offers training and examination entitled "Basic Certificate in Project Management". This level corresponds to the term "Advanced PM Methods" used in the table 2. Below this level, there is no training and examination which is why at the level of "Simple PM Method" no comparable equivalent is available.

Following on from the assessment that project management is used at all levels of Entrepreneurship Education, project management can be considered (as the Commission puts it) as the heart of Entrepreneurship Education.

What is actually learned in the project management-based lessons? Below, we do not tap into the potential of team-based learning for the development of personal and social skills. Investigations into this perspective have already been done. What interests us is the technology itself, the different elements that when put together form the technical system for "Project management". Put it another way: the intellectual tools of a Project Manager. Problem solving heuristics is at the heart of this.

2 Heuristics and algorithms

Heuristics (from the Greek heurískein = find, discover) and algorithms have a practical benefit: in both cases they apply methods in problem solving. Due to their same purpose, the terms are often also used synonymously. The methods themselves however differ considerably.

Firstly, the fundamental differences are in the subject areas that deal with heuristics and algorithms. Heuristics is today mainly found in psychology and is also referred to as "rules of thumb" or "rules of thought". Algorithms are in contrast a central theme of mathematics and computer science, whereby an important field of application is already named: software programming based on algorithms, not on heuristics. Because a computer handles complex algorithms faster than a person can, a shift has emerged with through their establishment: where complicated and complex algorithms are translated into computer programs while the people themselves only work with simple algorithms, or just with heuristics.

An example of a simple heuristics, recognition heuristics (recognition = to recognise), comes from Gigerenzer: "If you recognise one object, but not the other, then it draws the conclusion that the recognised object has a higher value." (Gigerenzer 2007, p. 123). These heuristics or "rules of thumb" can help in many situations: traffic (which street?), shopping (which product?) or in decisions (which opinion?). However, the use of heuristics depends on a necessary evaluation: Is it appropriate or not for the situation? Can I rely on heuristics in this situation? A computer during the processing of an algorithm, doesn't need to undertake such an assessment as the basis for decisions because the rules are already given. As a Demonstration of this principle, look to the problem that a salesman has: which is the shortest total distance? If the places to which will be travelled to are known, as well as the respective distances between these places, then by means of a simple algorithm for example, the Greedy Algorithm, the locations can be quickly and optimally calculated: start anywhere, call this "place 1", then travel to the next not-yet-visited location with the shortest distance and return to "Place 1". When all places have been visited and if you're at "place 1", finish the calculation. Instead of just distance, costs or travel times can also be calculated in relation to the question.

Algorithmic rules are mathematical procedure instructions which are subdivided into detailed steps and instructions. They determine what is to be done, how often, and/or how long to do it and in what order. The approach is grounded and hedged in rational logic. The heuristic "rules of thought" are in contrast more generally formulated. Heuristic rules are behavioural instructions to create a solution, they themselves do not however determine the solutions but present the solution options

and therefore always relies on the execution being continually reviewed, evaluated and decided. The procedure is justified and hedged through plausibility- and risk assessment. Gigerenzer speaks of intuition and the "intelligence of the unconscious", which is used here (ibid. p. 58).

Heuristics and algorithms have to solve the problem themselves as/if required, in how to act when dealing with missing information. A deterministic algorithm works only with defined and reproducible conditions. It has no flexibility and cannot deal with incomplete information. A randomised algorithm in contrast uses random numbers to fill the gaps and to control the flow through information gaps ("start location anywhere"). In contrast, a heuristic approach based on incomplete information, skips this and uses evolved capabilities (see Gigerenzer 2007) or experience and creativity (lat. creare = create, produce, to be prolific). At this point, the strength of heuristics is clear: while algorithm sets a process of complex calculation or a referred to as "arithmetic" (see Kluge 2002), the art of heuristics known as, little information ("limited information") with limited rationality ("bounded rationality") adapted to the conditions of the surrounding environment ("adapted to the structure of on environment") is used to find simple solutions to a problem in a short time ("fast and frugal") (see Gigerenzer & Todd 1999, p. 3f.). The time factor plays an important role here: "under time pressure one relies more on cognitive shortcuts" (Bieneck 2006, p. 20). On the one hand, heuristics are concrete enough to initiate solutions. On the other hand, they work blurred and in so doing, create for pros and cons alike: heuristics are also suitable for unclear problem situations (so-called "poorly defined problems"), while algorithms require a far higher level of clarity, structure and information (so-called "well-defined problems"). Heuristics are therefore also error-prone: heuristics can be situationally inappropriate or distorted by judgement errors. This phenomenon has been significantly shaping the scientific workings of the topic since the 1970s. The program could not be described more clearly: "heuristics and biases" (see Gilovich, Griffin & Kahneman 2002). Gigerenzer's research group brought to the fore the positive value of heuristics and thus allowed a (at least partial) rehabilitation of heuristics (Gigerenzer, Todd & ABC research group 1999). The central features of heuristics and algorithms are again described and summarised in table 3.

	Heuristic	**Algorithm**
Primary discipline	Psychology	Mathematics, computer science
Application example	Recognition heuristics	Greedy algorithm
Focus	Creation of solution areas	Processing of steps
Hedging	Intuitive plausibility- and risk assessment	Rational logic
Flexibilisation	Experience and creativity	Randomisation
Application	Poorly defined problems	Well defined problems
Challenge	Appropriate application in a specific situation	Development of a universal, error-free, and specific instruction

Tabelle 3: Heuristics and algorithms compared

While algorithms are likely used for well-defined problems regardless of the situation (comparable to a generic standard), the use of heuristics makes more sense in a

situational context with poorly defined problems, and it requires decisions to be made: can heuristics be applied in the current situation? And: while algorithms must be clearly executable, heuristics respond to ambiguity: the solution is possible, perhaps even likely, but not certain.

Why do we engage ourselves with heuristics? The blurriness of heuristics in project management under certain conditions is a strength: how to deal with ambiguity? An algorithm would fail in such general conditions and would "hang themselves" in an iteration loop. In contrast, a heuristic solution creates options, simple because it is less specific and requires continuous reflection. Heuristics also promotes competence development in project management. Competence in project management in turn means, understanding the basic heuristics of a method (e.g. project structuring). Only such an understanding enables the necessary methodological flexibility and creativity in dealing with uncertainty and complexity and situationally appropriate competent application of problem solving (see Gessler 2014).

This article is dedicated to the collection and description of personal heuristics by project managers. The key question here is: What intuitive logic is the underlying reason for success?

3 Complicated and complex problems

A problem generally comes about if objective condition and the initial condition are different. We distinguish between well-defined and poorly defined problems. While a well-defined problem has a clear objective and is reachable by known means, a clear objective however is lacking for poorly defined problems; the means to be deployed are therefore also unknown. An example of a well-defined problem is the game of chess: players, characters, game field, rules and the objective are all clearly defined and known.

To transfer the objective state to the target state, barriers to overcome solutions are required. Two barriers have already been mentioned: unclear objective criteria and unknown means (see Dörner 1976). Dörner describes these as complicated barriers. Complicated barriers represent a simplification because stable conditions are assumed which rarely exist. The factor "Time" and the resulting dynamics of the field, and of the environment, are excluded. The category "complex barriers" takes these dynamics and other conditions into account.

Dörner (1992) as well as Dörner and Schaub (1995) distinguish different characteristics of complex problem situations. These characteristics can be grouped as follows:

1. Complexity (wide variety and interconnection): Complexity is characterised by a wide variety of interdependent variables (see Dörner, 1992, p 60)
    - Wide variety of variables: A situation may exist from a wide variety of variables that are significant or could be, and are therefore to be observed. "Since this is not possible with limited time, you must somehow make a selection or summary." (Dörner & Schaub, 1995, p 38)
    - Interconnection: Different variables are interconnected to each other and influence each other. "In a networked system you can never just do one thing.

[…] That implies the necessity to observe "everything" when making decisions." (ibid.)

2. Dynamics and Irreversibility: The (self) dynamic results from the interconnectedness of the variables and whereby because of positive or negative feedback effects, no retrogression to the initial situation is possible. Even without intervention situations change whereby time pressure can occur.
3. Lack of transparency: Complex problem situations are usually only partially ascertainable or accessible. "Not everything is visible, what you actually want to see." (Dörner 1992, p 63)
4. Objectives (Polyteile (various objectives) and openness): On the one hand different objectives can co-exist, and on the other hand, the objectives themselves are initially vaguely identifiable.
   - Polytelie: In a complex problem situation usually there are several objectives at the same time, which support each other and/or even hinder each other, therefore necessitating the need for prioritisation in either cancelling objectives or in making compromises.
   - Openness of the objective situation: Objectives in complex situations are often not specifically specified, but only relatively set as better, worse, more or less. Non-specific objectives offer little guidance for target-oriented actions.
5. Situation and effect assumptions (innovation and modelling): Usually in complex situations neither knowledge about the current state of a system is suffice, nor are the relationship effects, the consequence and the side effects known.
   - Innovation: Complex problem situations are usually fully or partially innovative which is why there is a requirement to explore the situation and form hypotheses.
   - Modelling: Exploring the situation provides information to the current state of the situation. Knowledge is not only knowing, "what the case is, but also what the case will be or may be in the future, and one must know how the situation in relation to specific interventions is likely to change." (Dörner 1992, p. 64). A model is required that change the variables of a system depending on specific interventions or non-interventions. This effect assumptions (if then) can be explicit and writeable for others or even be implicit and perceptible (i.e. intuition) or imperceptible, but yet still be a call to action. Modelling is particularly difficult due to the many interdependent variables, dynamics and transparency of complex problem situations, and often the model used is simply wrong due to the incorrect assumptions of effect.
6. Subjectivity (cognition and emotion): Complexity, dynamics, objective openness, Polytelie and situation and effect assumptions are not objective properties or objective perceptions, but subjective variables.
   - Cognitive handling of complex situations: Through "super signs" such as the recognition of patterns or a form which can, due to experience, reduce the complexity of a situation. "Super signs reduce complexity; from a wide range of characteristics come one. A system is always complex with regards to a certain person with his character repertoire." (Dörner 1992, p 62)

- Emotional handling of complex situations: Emotions influence cognitive processes. Given the same requirements (e.g. lack of transparency, Polytelie, openness of the objective situation, dynamics) these can be perceived differently from person to person. A possible (incorrect) reaction is that, in one example, rash decisions/actions being made in a stressful situation without objective and situation clarification, without hypotheses - and modelling, with possibly a paradoxical effect that does not decrease the requirements and the perceived burden. Dörner describes the behaviour of a test subject as follows: "the subject learns almost nothing during their entire development, falls more and more in an aggressive helpless mood, save himself with non-effective routine procedures to give himself the feeling: "I am doing something!"" (Dörner 1992, p. 231).

While in the paradigm of "complicated barriers" it is assumed that the existing problem of information can be solved, "complex barriers" (are for example lack of transparency and momentum) which in principle are not manageable, only adjustable. Project management is an "adaptive regulatory procedure" to overcome complicated and complex barriers in the project work. Adaptive because the form of project management depends on the problem. Here, heuristics are interesting as "rules of thought" or "rules of thumb" to overcome barriers and to solve more complicated and complex problems. But which heuristics do Project Managers use?

4 Heuristics in project management

In project management various heuristics are used simultaneously without necessarily being always made explicit. They are a rather implicit part of the methods applied by project manager's instruments and strategies. The below outlined heuristics were extracted from a content analytical study of 19 narrative focused interviews (male: 12, average age 48 years; female: 7, average age 44 years). The project managers surveyed had at least six years full-time professional experience in project management.

Presented below are five Central PM heuristics. In addition to these more have been identified, however these were not carried out because the scope is limited. Then the PM heuristics were referenced in relation to the above characteristics of complex problem situations.

4.1 Heuristics "Exploration and clarification"

This heuristic appears to be so simple that it apparently needs no explanation. In the project questions are continuously answered. Firstly however, it is required to ask the right question to the right person, at the right time, and in the right way. The heuristic itself is simply, the implementation is not. On the basis of the interviews, the appropriate rule of thumb can be defined as follows:

1. Request what the various persons (participants and affected parties) wish, hope, expect, assume and fear.
2. Continuously clarify the wishes, hopes, expectations, presumptions and fears.
3. Fix answers (in writing if possible) and

4. Regularly check whether new questions are to be asked and that the already attained responses are still valid.
5. Continuously question and clarify to determine the location and the trends, so as to gain an overview and verification of assumptions.

The rule of thumb applies not only applies between the client and the project management, but also within the project as well as the environment. Appropriate questions and answers are often only developed discursively in an interview. The people participating continuously ask themselves and others questions so as to determine the location and the development trend, to gain an overview and to question their own and shared assumptions, and to develop clarifications.

4.2 Heuristics "Boundary and boundary crossings"

The need to define boundaries and boundary crossings, the setting and checking these and if necessary, applying changes is a fundamental task in the project management. Projects are often referred to as "undertaking over a set amount of time". The project leader is an "undertaker over a set amount of time", who from establishment to conclusion "his undertaking", designed the course by preparing, applying or self-defining the definitions.

That Project Managers may not always be a part of the establishment of their "undertaking" is just one of the many possible errors: The context of a project cannot be understood without its history. A project begins before the official launch and is in effect until the official end. It's exactly these grey areas that require the setting of borders and definitions: how will the transition to the project be made? How will the projects boundary and the environment be defined, designed and maintained? What happens after the completion of the project and how will the transition to the post project period, the application, implementation, etc. take place? The heuristics "boundary and boundary crossings" includes basic questions for the formation and creation of boundaries by means of definitions: (1) definition of the boundary (including: when does the project start, when does it end? What is the available budget? What are the objectives, what aren't the objectives? What is belongs to the project scope ("in-scope"), what is not part of the project scope ("out-of-scope")? Who belongs to the core team, who to the extended team? What is the environment? Who belongs to the environment? Which environment is relevant, which environment is not relevant?). (2) Definition of the border crossings (including: how will the transition of the project happen, such as the transition to the post project period? How will the transitions between the phases of the project happen? How can the defined budget be changed? What is required? How will the scope of performance be changed? How are additional wishes dealt with? How is the project integrated into the overall organisation? How are members of the project welcomed and bid farewell? How is the flow of information between the project and its environment regulated?). On the basis of the interviews, the appropriate rule of thumb can be defined as follows:

1. Define what/who belongs to the project and what/who does not.
2. Define the boundaries at least with respect to the dates, costs, performances and the organisation.
3. Define the border crossings, the transaction, and the exchange.
4. Define how to change boundaries and boundary crossings.

The more detailed and comprehensive the definitions at the organisational level and the presets (standardisations) are, the less effort is then needed in the project to clarify the general situation. This can on the one hand lead to a limitation in the room to manoeuvre and restrict self-control. On the other hand predetermined project standards can relieve formal definition work, which allows for increased freedom of development and room to manoeuvre in terms of self-control.

4.3 Heuristics "Black Box"

Often, it is neither necessary nor desirable to provide a work order in detail. The rule of thumb is that instead of the detailed definition, a "Black Box"[1] is created: A working unit will be differentiated. An expected result will be defined (jointly) and a person will be designated who is responsible for the achievement of the result. The way of working, the concrete approach to the solution of the problem, is not given.

In the project, heuristics is finds itself on various levels of abstraction: The smallest "Black Box" form the work packages. The scope and the results of the work package are defined and given to the person responsible for the work package. The specification of finding the problem solution, and to find and manage the conglomerate of the individual activities, is the task of the person responsible for the work package. They then report the progress of their work to the project manager, ideally and typically at the results level and not at the activity level. The next application-level forming the sub-projects are then further "Black Boxes" etc.

EXCURSUS: Three components of professionalism are distinguishable according to Abbott (1988): "Diagnosis" (problem analysis), "Inference" (deriving the necessary measures) and "Treatment" (implementation of the measures), where inference is a "purely professional act" (ibid., p 40). Conflict can occur with the deprofessionalisation effect if the degree of freedom is limited for professionals with regard to the autonomous deriving of the necessary measures (see Mieg 2000, p 72 f.). In contrast, by inference, non-professionals need targeted and accurate assistance.

The responsibility for the result, and the delivery of the result is coupled to a second, separate to this responsibility ("define boundaries and boundary crossings"): the responsibility for the acceptance of the results and the evaluation of performance. Work package responsible responsibilities for the result in respect to sub project management or project management; Project and program managers are responsible for their

[1] The term "Black Box" comes from the engineers. When drawing a diagram of a complicated machine a kind of shorthand used. Rather than drawing all the details, they use a box that represents the whole conglomeration of parts and denote the box with what this conglomeration of parts should do." (Bateson, 1994, p. 75)

performance on behalf of the client. On the basis of the interviews, the appropriate rule of thumb can be defined as follows:

1. Limit the problems and define the output or result for this.
2. Transfer the responsibility of achieving the result to one person.
3. Separate the responsibility to quality assurance, to achieve a result by the responsibility, to accept the result.
4. Only through the acceptance of a result is the provider relieved of their responsibility for results.

4.4 Heuristics "Tree structure"

A basic necessity in the project management is to work from the "rough" to "fine". The first objective is always to gain a rough overview at a general level, to then work towards the details: The fine objectives arise from the rough objectives, the stake holder analysis arises from the identification of the promoters and opponents, the work packages arise from the project structure plan (structured outline of results-oriented activities/functions or all results to be achieved), the workflow and time schedule is created from the phase plan, risk analysis arises from risk identification. Tree structures are created. The difficulty of this top-down approach is to obtain the references as a whole and the integration of miniaturisation as a whole. This is why the bottom-up structure is to be continually consolidated so that the context is not lost. On the basis of the interviews, the appropriate rule of thumb can be defined as follows:

1. Work top-down and detail from rough to fine, and from large to small.
2. Work bottom-up and integrate: from small to large and from fine to rough.
3. Continuously check coherence and pay attention to the integration.

4.5 Heuristics "Recursion"

This heuristic is visible e.g.

- in the idea of the "rolling planning" (also known as Rolling Wave Planning): An already compiled plan is taken up at a later date and further processed, renewed, discarded, detailed.
- in the idea of the PM phases and the PM processes: A project consists typically of five PM phases: initialisation, definition, planning, leadership and completion. Each phase in turn usually consists of five PM processes: Initialisation, definition, planning, leadership and completion.
- in the idea of specifications and functional specifications: The client formulates their order in the specifications 1, the project management is based on this framework and formulates the services in the functional specifications 1. Then the client renews their specifications and communicates these 2. Version. Project management then apply the changes and so on. Similarly the tree structure is worked from rough to fine. The special thing here is the recursive circular strategy.

On the basis of the interviews, the appropriate rule of thumb can be defined as follows:

1. Repeat planning and working steps on the basis of new knowledge.
2. Integrate later results with previous results and correct if necessary.
3. Set a framework for orientation, set in concrete, and set a new framework for orientation.[2]

In conclusion, the outlined heuristics with the characteristics referring to complex problems are used.

5 Effects of Heuristics

The five heuristics have a regulatory effect on the above characteristics of complex problems in projects. The combination of heuristics and requirements (characteristics of complex problems) is, according to our thesis, the logic of success (see Table 4).

Heuristic	Has a regulatory effect on complex problems...
Exploration and clarification	Subjectivity: Dealing with the subjectivity of complex problem situations through ongoing (discursive) questioning and clarifying. The heuristics influences all other heuristics.
Boundaries and boundary formation	Complexity and objectives: Dealing with the networked variety of variables and objectives through the ongoing definition of variables, interfaces and objectives while limiting the scope of application. Also affects transparency: In particular through controlled defining, the boundaries arising through the lack of transparency become apparent.
Black Box	Lack of transparency: Dealing with the lack of transparency due to orientation on the result rather than the specific actions. A certain degree of a lack of transparency is consciously accepted ("Black Box"). Also has an effect on the situation and effect assumptions: In particular as building blocks or elements of the models.
Tree structure	Situation and effect assumptions: Handling of unknown interdependencies through a step by step approach, definition, integration and revision (from the rough to the fine and the fine to the rough etc.). Also affects Dynamics: The heuristics allow for dealing with time pressure because initial provisional decisions are possible.
Recursion	Dynamics: Dealing with the dynamics of situations, the feedback effects, follow-up, and side effects of interconnected variables by recursive Optimisation of the situation- and effect assumptions. Also has an effect on the situation and effect assumptions: In particular through continuous optimisation.

Table 4: Effects of Heuristics

[2] In mathematical optimisation an algorithm was developed, which also works with growing thresholds: the so-called deluge algorithm (see Dueck, 2004).

5 Summary

Initially heuristics were defined in contrast to algorithms. The different types of heuristics makes it necessary that these be situationally decided and applied. Therefore, competence (in particular, experience and creativity) is required. In the second step, well defined and poorly defined problems have been distinguished as well as barriers identified that complicate the problem solutions in project management. Complicated barriers are: (1) "clarity of the objective criteria" as well as (2) "awareness of resources". Complex barriers are (1) "complexity (wide ranging and interconnection)", (2) "dynamics and irreversibility", (3) "lack of transparency", (4) "objectives (Polytelie and openness)" (5) "situation and effect assumptions (innovation and modelling)" as well as (6) "subjectivity (cognition and emotion)". In the third step, five heuristics were presented by project managers. These are: (1) exploration and clarification, (2) boundary crossings, (3) Black Box, (4) tree structure and (5) recursion. The fourth step listed the five heuristics and the six listed complex barriers and considered in conjunction with one another. Our thesis is: Inasmuch as problem-solving strategies, (heuristics) respond to the requirements of more complex problems (complex barriers) and in this case there is a congruence resulting in the logic of success.

Heuristics represent a strength in project management under certain conditions: How to deal with ambiguity? Heuristics is no guarantee for a good solution. It is a guarantee of the ability to act by means of exploring and clarifying, boundaries and boundary crossings, Black Box, tree structures and recursion in moving closer to the objective state, and to develop a logic for the success of the project. This applies however only under certain conditions: Personal competence is required for this purpose.

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