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Problem Identification and Planning

Identification de problèmes et planification

Problem Identifikation und Planung

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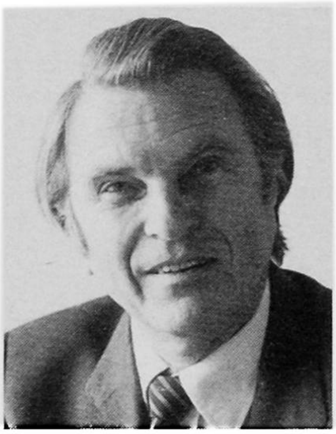


Richard Weidle, born 1922, got his civil engineering degree at the University of Stuttgart, Federal Republic of Germany. In 1948 he founded his own engineering office, later Weidleplan Consulting GmbH, a multidiciplinary consulting company working in more than 20 Middle East and African countries. Mr. Weidle is Chairman of the Board of Directors.

SUMMARY
Problem identification is a planning step in which the task set for the following planning and design work is defined. This can basically take place in any design phase of a project. At the beginning of the project, however, is when problem identification takes on its greatest signification. Problem identification and its methodical integration into the planning and design is dealt with in 5 steps, which are presented in this contribution.

RESUME
L'identification des problèmes est une phase de la planification dans laquelle les futures tâches sont définies. Ceci peut se faire généralement lors de chaque phase d'un projet. Il est évident qu'au début d'un projet, l'identification de problemes est le sujet le plus important. L'identification de problèmes et l'intégration systématique dans la planification se fait en 5 étapes, lesquelles sont décrites dans l'article.

ZUSAMMENFASSUNG
Problem Identifikation ist ein Planungsschritt, in dem die Aufgabe für nachfolgende Arbeiten erarbeitet wird. Dies kann grundsätzlich in jeder Planungsphase eines Projektes erfolgen. Zu Anfang des Projektes kommt der Problemidentifikation jedoch die grösste Bedeutung zu. Problem Identifikation und deren methodische Integration in die Planung erfolgt in 5 Schritten, welche im Bericht erläutert werden.

In his Introductory Report on the main topic, Prof. MacGregor described problem identification and planning as a study of

- what is needed
- why it is needed
- the objectives and criteria to be used
- the resources available

This speech goes on from there and defines problem identification in general as a design stage, in which the task is determined for the following design stages. The more clearly a problem is identified and the task set for the designer, the sooner and easier an appropriate solution presents itself.

The significance of this design stage cannot be over-estimated. It often happens that it is decided at the problem identfication stage already whether the project will be successfull or not.

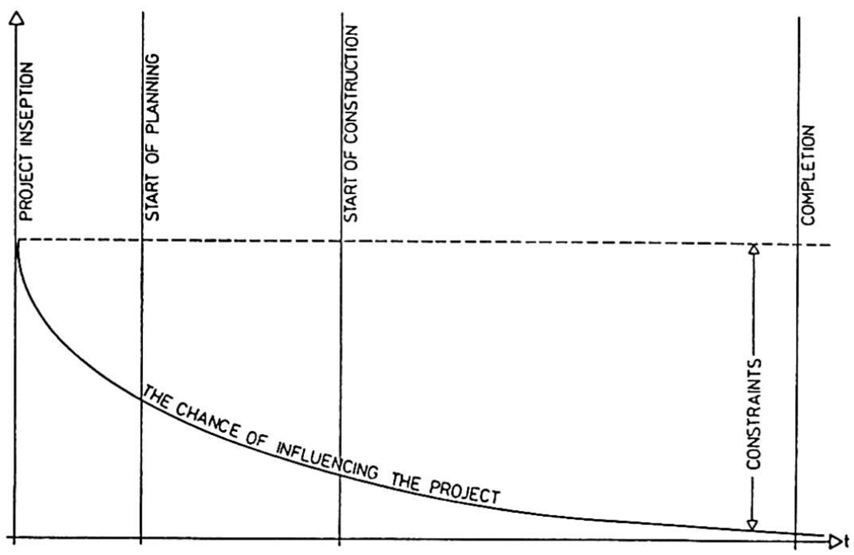
Problems which have not been recognized in the early stage of a project later lead to difficulties and hence either

- to unfavourable compromises
- to the acceptance of an inferior solution and lower quality
- to higher costs
- to going back and starting afresh with design work, which represents loss of time and money

or even to damages in construction at a later stage.

The entire design process can be considered to be a series of solutions to problems, each solution being more detailed than its predecessor. In this respect, problem identification plays a role in every stage of the planning and design, with the number of alternative solutions decreasing greatly according to the progress of the design process. The graph in Figure 1 shows that very many influencing possibilities are to be found at the beginning of the design process, and practically every type of freedom in planning is open.

Figure 1: Degree of Freedom in relation to Planning Progress



With increasing progress made on the design process and on the decision involved therewith, the degree of freedom and the possible solutions diminish relatively rapidly, so that at the end of the design process, which in many cases already overlaps with the construction execution, the possibilities of influencing the project is only very slight. Or, to put it another way: the constraints caused by previous planning decisions are so great as to leave little in the way of latitude for alternative solutions. This curve in particular, with which everybody is sure to be acquainted, should be recalled time and time again, because it is a clear pointer to the significance of problem identification at the beginning of a design process.

Generally there are two methods of proceeding to expose the core of a problem: the empirical approach of the great master on the one hand and proceeding with method on the other. These two methods are not mutually exclusive and at all events call for a high degree of knowledge and skill. The following is a brief introduction to the general structure of decision ability, taking up one of Prof. Hallasc's thoughts.

Figure 2: Intensity/Band-Width of Knowledge to reach Decision Level

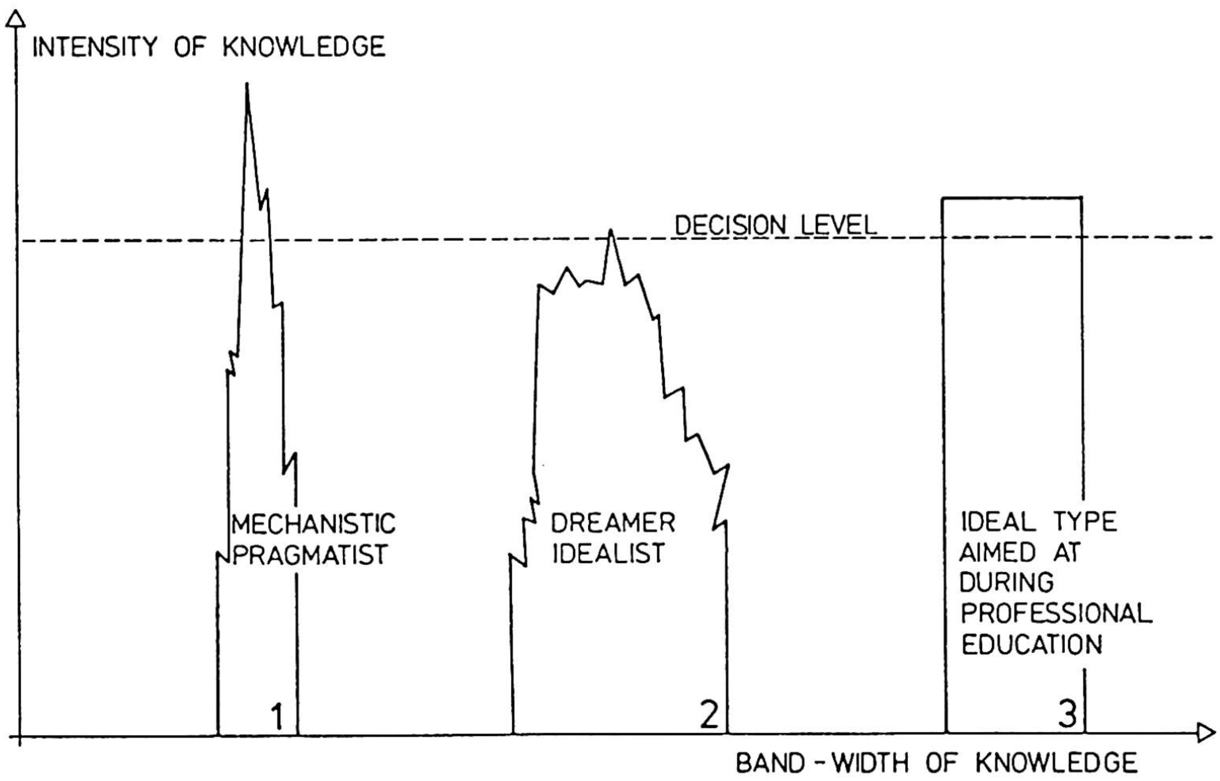


Figure 2 shows a diagram in which the vertical axis represents the depth or intensity of knowledge and the horizontal axis the band-width or amount of knowledge. The dotted line above represents the decision level. This shows that a great degree of knowledge is needed to be able to reach and cross the decision level, thus enabling a decision to be taken.

Sketch 1 depicts the actual position of scientists and engineers, with the depth or intensity of the knowledge diminishing towards the top. However, a very considerable area of knowledge breaks through the decision level and in part even oversteps it considerably. Sketch 2 shows the type of the more emotional being or "dreamer", who has a wide horizon of knowledge. Out of this group nearly nobody reaches the decision level, only the great masters. Sketch 3 shows the ideal type who reaches beyond the decision level with the whole extent of his knowledge. University education ought to aim at this type and also create the appropriate conditions.

Design stages in which the exact problem is not yet known need to an even greater extent a broader established decision ability. This also results in the necessity of having step-by-step methodic procedure. An aid for mechanical engineers is the directive from the Association of German Engineers with the title "Construction methods - conceiving technical products"

This step-by-step methodic procedure may be split into the following five steps:

1st Step: Basic Information

The project contract often does not contain the information required for determining the task. This information has to be procured. In doing so, the following questions should be looked into:

- what is the core of the task?
- which wishes and expectations exist?
- do the conditions laid down in the scope of task apply?
- which paths are open for development?

The planning objectives must be determined. When so doing, the following questions are useful:

- what purpose must the actual solution serve, what features must it have?
- what features must it not have?

The following are recommended for collecting information:

- finding out of fixed data and focal points
- checking the state-of-the-art
- judgement of future developments

After all the information has been collected, work can begin on elaborating the requirements.

2nd Step: List of Requirments

For later assessment of solution variants and to facilitate decisions, differentiation must be made between requirements and wishes. Requirements or at least minimum requirements can be quantitative data or descriptive data, such as

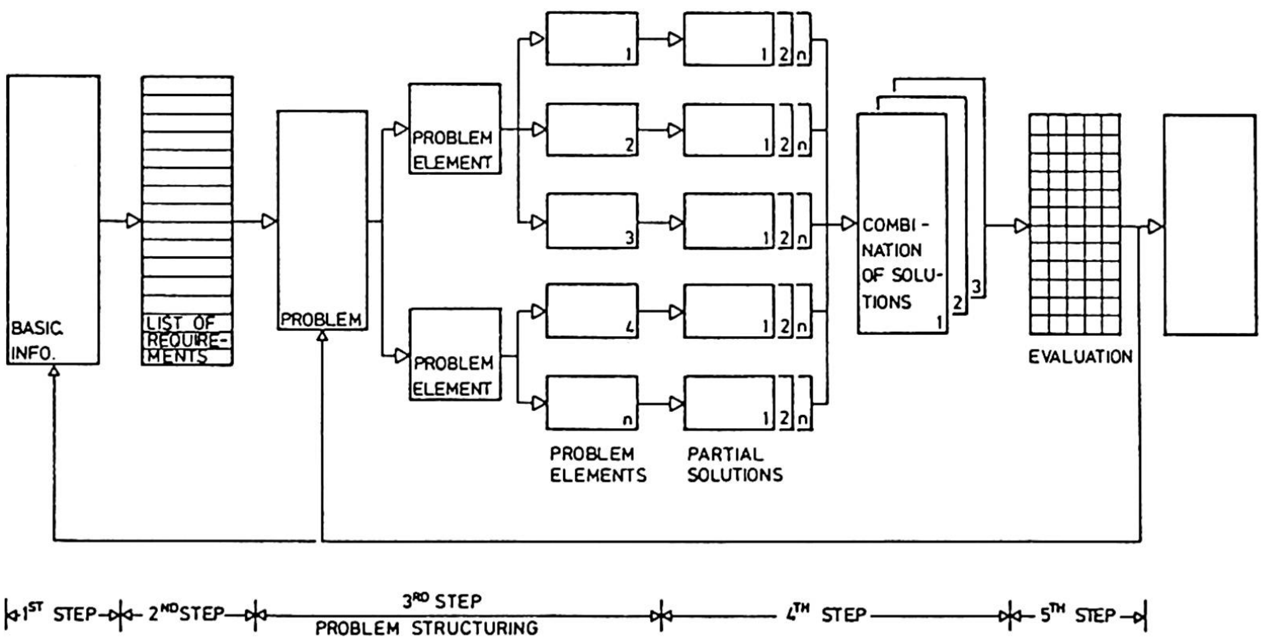
- utilization requirements based on demand investigations (e.g. loads, areas, etc.)
- surrounding conditions such as foundation, soil, climate, earthquake, wind, material available
- safety - covering fire protection, fire escape routes, attacks, symptoms of material fatigue
- costs: here the total costs should be considered, i.e. investment costs including later operating and maintenance costs
- construction and planning time

Wishes should be considered where possible, under certain circumstances accepting a limited amount of extra effort and expenditure.

Wishes could be:
- demands on convenience, including air-conditioning, comfortableness, variability of utilization, protection against environmental influences and emission
- Aesthetic demands such as the call for something special, the integration of the structure into the landscape, characteristic design for a particular project.

Wherever possible, the demands will be compiled in a requirement list or project description.

Figure 3: Finding of Solution by Problem Structuring



3rd Step: Problem Structuring, Division of the overall Problem into Problem Elements

The step which now follows seems to be one of the most important: the structuring of the problems. Problem structuring can be defined as the transformation of a vague formulation of task into a solvable problem description.

In doing so, the problem elements, which occur in part by listing the individual requirements and in part as a result of their superimposition and/or combination, are to be brought into relationship with each other. Hierarchical structures must be developed for each project and must portray the value of the individual problem elements. These would have to be orientated to the overall aim to be reached, to the technologies to be applied and would have to finally reach a form of representation which clearly shows how a solution to the problems is possible.

In this connection it should be especially mentioned that solutions predetermined in the design contract - insofar as they are not imperative - are often a hindrance in finding optimum solutions. As far as the problem structuring and identification are concerned, this means that the problem is formulated along abstract lines and that only the essentials are accentuated. If, for example, the requirements stipulate "prefabricated elements shall be used, to reduce construction time in the problem identification this would be softened to "minimum construction time is to be achieved". General information of this kind leads on the one hand closer to the core of the problem, on the other hand it encourages several alternative solutions.

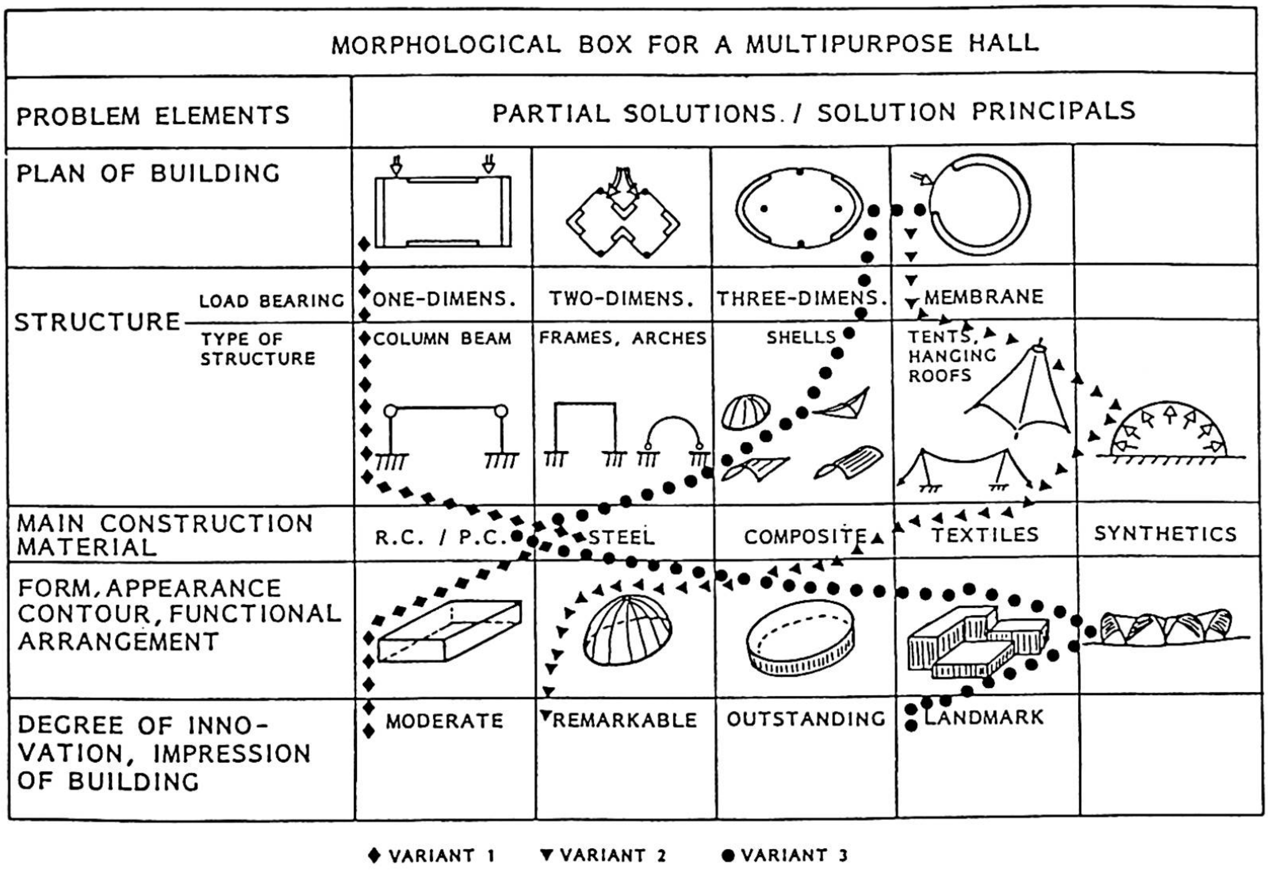
4th Step: Partial Solutions and Combination of Partial Solutions.

After structuring of the overall problem into well-defined problem elements, which are clearly allocated to each other, solutions to these problem elements can now be worked out.

Figure 4: Schematic Morphological Box

PROBLEM ELEMENTS		SOLUTION PRINCIPLES						
		1	2	•	i	k	•	m
1	F_1	P_{11}	P_{12}	•	P_{1i}			
2	F_2	P_{21}	P_{22}	•	•	•	•	P_{2m}
•								
•								
n	F_n	P_{n1}	P_{n2}	•	•	P_{nk}		

Figure 5: Morphological Box for the Design of a Multipurpose Hall



The morphological box has proved its worth in the systematic finding of ideas and as a representation, providing a clear overview. The morphological box, in the form of a two-dimensional array, is shown in Fig. 4. In the case of the morphological box, one proceeds on the assumption that each whole problem can be broken down into problem elements, which, in turn, when combined together, form potential overall solutions. The box can in fact be applied in order to find solutions for the respective whole problems to any system, consisting of whole problems and n problem elements.

In the 1st column the n problem elements are entered, designated F1 - Fn, as far as partial, corresponding to the sequence of their taking effect. The possible solutions associated with each problem element are listed in the appropriate lines. Any arbitrary combination of partial solutions will lead to a possible solution; the number of results shall be denoted "Z".

Theoretically, the maximum number of solutions is the product of the number of partial solutions in the first to n-th line. Hence, for a complete matrix, maximum Z will be m^n.

Formerly, one aimed at the highest possible value of Z and it was recommended, like in a chess play, to check in one's mind all connection lines seeming to make sense and to select those, which seem the most promising. This, however, involves a lot of effort and is basically also not necessary, insofar as a specialist is the one selecting the possible solution.

During this process, the specialist can fulfil the basic demands from the outset, namely:

a) Disregarding theoretically possible solutions which are obviously not feasible

b) Avoiding the linking of partial solutions which are incompatible with each other

It is advisable to put a) first and not to start on evaluating the morphological box until afterwards, which leads to the span of solutions being greatly diminished.

Even then, however, only those solutions which fulfil the basic requirements of b) are of any use as solutions to the overall problems. Figure 5 shows an example of a simplified morphological box for the design of a multipurpose hall. The various alternatives are shown and how the partial solutions can be combined.

5th Step: Evaluation of Concept Variants

One arrives at concept variants by combining partial solutions. These variants now need to be evaluated. The requirements and wishes compiled in the list of requirements present themselves as evaluation criteria or objectives.

In practice, depending on the type of task set, the evaluation and decision in favour of a variant in the form of a discussion or as a formalized evaluation procedure has proved its worth. It is important to keep minutes of the decision taken in a discussion in order to be able to re-examine the decisions made, should the parameters change in the future.

It is not likely, that any one potential solution will represent an ideal match to all requirements and objectives. So the advantages and disadvantages of one solution have to be traded off against each other to separate the most desirable variant. Very sophisticated techniques of decision-making have been developed in recent years. A very simple, yet powerful method is to award points to each evaluation criteria according to their technical and economic merit. In doing so, a so-called "use value matrix" is set up as tabular compilation of the evaluation. According to their importance, the awarded points for each criteria are multiplied by a weighing factor. The totals of weighed points for each variant can now be compared with oneanother. It must be noted, that the number of points, as well as the weighing, may be correlated or non-linear and are heavily dependent on the judging individual. Figure 6 may serve as an example for such an evaluation table.

Even during this phase alternatives are often sought for weaknesses discovered in the conception which present themselves in the course of the evaluation.

Figure 6: Evaluation Table for Concept Variants

FIG. 6 EVALUATION TABLE

EVALUATIÓN CRITERIA		Weighing Factor	Variant 1		Variant 2		Variant 3	
			Points	Weigh. Points	Points	Weigh. Points	Points	Weigh. Points
FORM 20%	Uniqueness	10	2	20	4	40	10	100
	Integration into Environment	10	5	50	4	40	6	60
FUNCTION 20%	Variability of Utilization	6	10	60	5	30	6	36
	Sight Line	8	7	56	6	48	4	32
	Natural Lighting	3	6	18	2	6	5	15
	Acoustics	3	6	18	5	15	4	12
SAFETY 10%	Fire Resistance	7	4	28	2	14	5	35
	Resistance against Environm. Impact	3	6	18	4	12	6	18
COSTS 30%	Building Costs in resp. to Lifetime	15	8	120	2	30	5	75
	Maintenance Costs	10	5	50	2	20	6	60
	Utility Costs	5	7	35	3	15	7	35
CONSTRUCT. TIME 5%		5	6	30	8	40	4	20
OTHERS 15%		15	4	60	5	75	4	60
100%				563		385		558

The result of the evaluation is a solution of the problem initially identified on the one hand, and the point from which to proceed with the following design stage on the other.

The methodical steps towards problem identification and towards working out solutions to the problems which have been shown here are basically applicable in each design phase. In accordance with Figure 1, however, the problem span is narrowed down further as planning and design process, and the tasks set become increasingly more specific. Whereas one is at the beginning still deciding on the overall conception of a building, later on, concepts, such as fire-fighting, facade elements or site mobilization need to be developed.

The requirements become increasingly easier to qualify and the problem itself easy to identify, for example, "selection of corrosion protection" or "design of a bearing". One would then no longer take the trouble to set up a morphological box, but would rather only develop design alternatives and variants and then evaluate these (See Figure 6 as an example).

Experience has shown, that in the course of the short periods available for the planning and design work and in the initial feeling of euphoria when starting on a new project, one is in danger of committing oneself over-hastily to one design solution. Not until continuing work on the project which is in progress, does one hit on points which cast serious doubts on the design. Such errors can be avoided if one incorporates problem identification quite consciously as a design stage - a design stage which can approach very systematically and integrate into the later design phases.

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