Mechanical Design Engineering Handbook 2E
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Creative Problem Solving

Extract from the Mechanical Design Handbook

In addition to developing and formulating effective rules for brainstorming, Osborn and Parnes also considered the process of solving a problem (Parnes *et al*. (1977)). They developed an approach for this, comprising 12 steps and six stages, called the Creative Problem-Solving process (CPS). The process is based on phases of divergent and convergent thinking, illustrated schematically in Figure 3.6, and is one of the oldest structured frameworks for problem solving.
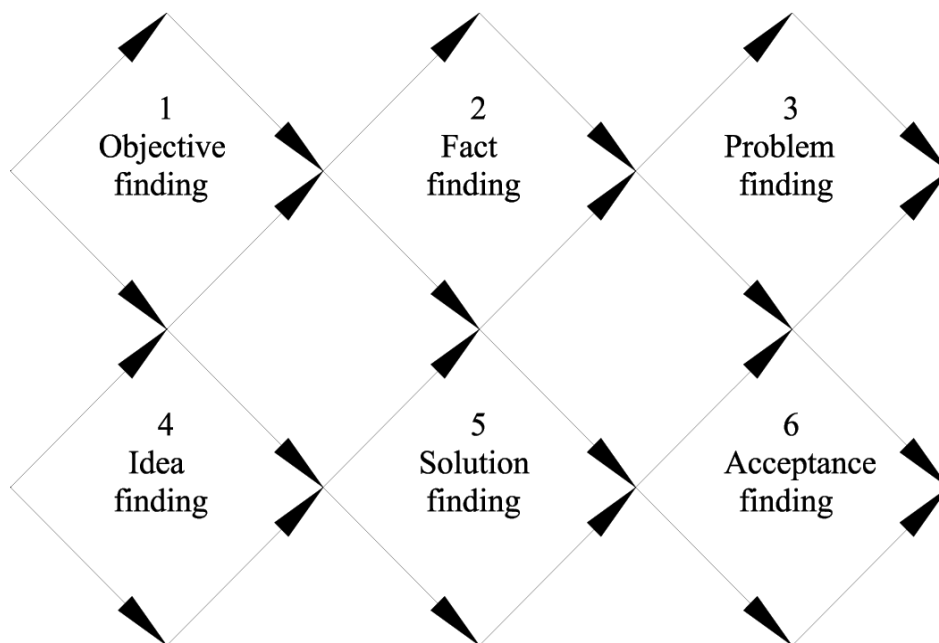

Figure 3.6: The Creative Problem-Solving process

The six stages of the creative problem-solving process which feed sequentially into each other are:
- Objective finding – An objective can arise from experience and day-to-day life, requirements of the domain and social pressure.
- Fact finding – Information relevant to the issue that needs to be defined. For example, limits on allowable size or mass, how many users there are, and are there any legal requirements.
- Problem finding – For any task, there are associated challenges that need to be resolved. In the context of creative problem solving, problem finding relates to exploring what the deficiencies of existing solutions really are or which issues or challenges arise in tackling the problem.
- Idea finding – The generation of multiple concepts that may be useful and relevant to the challenge.

- Solution finding – Elaboration is necessary in order to turn any idea into a viable solution. Elaboration may involve exploring design issues in some further detail providing embodiment to the idea so that there is confidence that it will work.
- Acceptance finding – Clients and peers need to be persuaded that the idea developed is going to work. A bright idea on its own is not enough. Instead any issues relating to it need to be explored in sufficient and convincing enough a manner that all relevant parties, clients, colleagues, end users and customers can be persuaded that the solution is the right one.

Osborn and Parnes recognised that creative problem solving requires convergence as well as divergence, and each stage of CPS involves this. The divergent phase requires creative thinking where you encounter paradoxes, opportunities, challenges and concerns, and search and generate possible solutions. This may involve generating many new and varied potential solutions and details that may contribute towards a solution. The convergent phase requires critical thinking with examination of the possibilities and focusing of thoughts. This may involve organising and analysing the potential solutions and refining them to improve their viability. Potential solutions can be ranked and prioritised so that attention can be concentrated on developing particular ideas. Each stage can involve use of brainstorming with deferment of judgement, production of many ideas and looking for combinations of ideas, prior to sifting and refining these ideas.

Effective tools are required to help evaluate competing ideas in order to overcome the temptation to slam an idea as unworkable at too early a stage in its development. Tools for focusing options, recommended by Treffinger *et al*. (2006), include:

- Hits and hotspots – Identifying promising possibilities and clustering and organising them to see if meaningful insights can be identified.
- ALoU – Advantages, Limitations and Unique features – Consider the advantages, limitations and possible methods to overcome them and the unique features of an idea in a constructive manner with a view to strengthening the idea.
- PCA – Paired Comparison Analysis.
- Sequencing – Short, Medium and Long-term actions.
- Evaluation matrices.

In application of CPS or any creative method, considering the magnitude of the challenge is as important as assessing whether there is a high level of tension or conflict in the group of personnel involved. If an initial exploration of the data available reveals that the task to be undertaken is large, then subdivision of the activity may be appropriate with delegation of duties to specific sub-teams. If there is already a high level of tension or conflict in a team, then conflict resolution or team-building techniques will need to be employed.

CPS can be used when working individually or in a team (Isaksen (2000)). If working in a team, then this will require more planning and resourcing than if working alone as it will require coordination of several people and provision of resources.

The six stages of CPS can be grouped in phases.
- Identify and clarify the challenge: Stages 1-3
- Finding solutions and evaluation: Stages 4 and 5

- Putting the solutions into action: Stage 6

A statement of opportunity does not represent a statement of a problem. The purpose of identifying and clarifying the challenge, stages 1-3, is to enable define the problem you need to resolve and to give a direction to the effort. Asking questions *who*, *what*, *where*, *when* and *how* can be useful in identifying key data relevant to the problem. In addition, considering a future desired state in the form of an ideal final result can inspire formulation of the problem statement to enable you to get from the current status to fulfilment of the objective.

Problems sometimes arise as a result of dire prospects or from aspirations and wishes. Two facilitating constructs used in CPS to explore these situations are WIBAI and WIBNI. These represent '*Wouldn't it be awful if …?*' and '*Wouldn't it be nice if…?*' These constructs can be used to explore and develop an opportunity. An issue may commence with '*Wouldn't it be awful if...?*' and be turned into a constructive opportunity by '*Wouldn't it be nice if...?*'

Experience in using the CPS technique has resulted in the use of a series of facilitating open-ended problem statements that invite ideas, including:
'*How might we…?*' or '*How might I…?*' HMW, HMI
'*In what ways might we…?*' or '*In what ways might I…?*' IWWMW, IWWMI
'*How to …?*' H2
These constructs can be combined with a verb and objective and used to explore and construct an opportunity. Examples of this are 'How might we extend the useful life of this product', and 'In what ways might we increase the chance of winning this bid?'

Constructs for encouraging divergent thinking include consideration of what options and alternatives there are or might be. Convergent thinking involves focusing attention on the hits or most appealing alternatives in an extensive list of ideas.

Once an idea has been explored and selected as the best option, it will be necessary to persuade other stake-holders, such as managers and colleagues, that it is the right idea. It is helpful to identify people and factors that can assist this. The 5Ws (*who*, *what*, *where*, *when*, *with whom*) can be used to consider, for example, who can help, what resources are necessary for successful implementation of the idea, when is the best time to implement the plans, where the ideas can be developed, and why the idea should be taken forward. In a similar fashion, detractors or resistance to an idea can be explored in order to mitigate against things that could go wrong. Again, the 5Ws questions can be used to identify who might criticise the ideas and potential responses for them, what resources might be missing or unavailable, when might the worst possible time be to implement or reveal the idea, where might the worst place or factory be and what are the least persuasive aspects of the proposition.