

# ME349

## Engineering Design Projects

### Concept Generation

After decomposing your design into a set of functions, the next step will be the generation of concepts to meet those functions. This is typically one of the most fun aspects of the design process. That is the reason that we usually want to start here and skip the previous steps. We wish to develop ideas for the functions at their lowest level of decomposition, that is, the simple functions defined. The steps of functional decomposition and concept development represent a diverging/converging process. We diverge to reduce the functions to their simplest level, then after concept generation these ideas will be combined into via ideas for sub-systems for our product. There are many methods that may be used for concept generation. We will discuss several techniques. Some of these are designed as group functions, some involve research and some simple reflection. The most important part is to develop as many ideas as possible.

### Research:

While is impossible to know of all previous ideas within a discipline, every effort must be made to find all previously developed design ideas.

#### *Patent Search*

One good source of previous designs is the Patent Search. To perform a patent search on-line, go to the US patent Office web site. ([www.uspto.org](http://www.uspto.org)). The “how to” link will allow you to “find existing patents”. You should first do a “quick search” of patent within the desired information area. This involves specifying two terms to describe the area to search (such as “playground equipment” and “handicapped”). The search will return the patent descriptions that include your key terms. If further information is desired you may perform an “advanced search”. The advanced search allows you to search based upon approximately 30 different criteria such as Title, Inventor Name, Patent Number, etc. For your purposes, the Quick Search will probably be more efficient

#### *Reference Books*

Reference book and trade journals can be a source of inspiration for design concepts. Although reference books are often analytical in content they can provide useful information such as power transmission systems and linkages. Trade journal are oriented toward specific disciplines and are a great source of design solutions with a narrow scope of application. Many trade journal now offer electronic versions of their publications and these may be searched on-

line. The Thomas Register is a listing of manufacturers, which can be a good source of who to contact in specific fields.

### ***Experts***

You will find it valuable to make use of all those who have previous knowledge in your areas of interest. Many experts exist locally through the university and state and local government. In addition, the internet has opened communications to a global level. Do not hesitate to seek out those with special knowledge for your inspiration.

## **Creative Idea Generation:**

### ***Brainstorming***

Brainstorming is probably the most common technique used for concept generation. It may be conducted individually or in groups. I would suggest both. When brainstorming on your own, be sure to record all ideas in your notebook and include sketches whenever possible. This will better enable you to recall and explain your ideas at a later date.

When brainstorming in a group it is best to follow a procedure. There are a few simple steps to conducting a successful brainstorming session:

- 1) Make sure that ALL ideas that are generated are recorded. You will want to appoint a recorder and then rotate this position every 5-10 minutes since the recorder will be so busy they will not have much opportunity to contribute. Pick a time limit and ENFORCE IT. Use a timer if you have one.
- 2) Think wild! Do not allow anything to inhibit your ideas. As engineers, we will often hesitate to mention an idea we feel may be technically impractical. Get over it! All ideas are welcome and needed.
- 3) There is to be NO CRITICISM and NO EVALUATION of ideas during brainstorming. We do not wish to stifle creativity and discussions of implementation will slow down the flow of ideas. This is a hard concept for some of you. You may need to work hard to avoid doing these things.

### ***6 – 3 – 5 Method***

The 6 – 3 – 5 Method is a group brainstorming technique that often yields very interesting results. The optimum number of participants is six and hence the number in the name. However, it can be performed with anywhere between 3 and 8 team members.

The method proceeds as follows:

- 1) Each member takes a sheet of paper and divides it into 3 columns by drawing lines down the length of the sheet
- 2) Each member takes 5 minutes and generates 3 solutions to the function being considered. Record these in the first column. The solutions may be written or sketches of combinations of both. They must clearly and concisely convey the ideas.
- 3) After 5 minutes the sheets are passed to the member on your right.
- 4) This person has 5 minutes to examine the ideas on the sheet, generate 3 more ideas, and then record them in the next column. These ideas may build upon the previous ideas or be fresh approaches.
- 5) Repeat the process until you have your original sheet back.
- 6) NO TALKING is permitted during the entire exercise.

### ***TRIZ Method***

The TRIZ method is detailed in other materials on the course web page.

### **Problems Encountered:**

#### ***What a lack of concepts means***

A fundamental assumption was made in defining the function. The function therefore was gauged only for a single concept. Revisit the function and remove the assumption.

The function is directed at “how” rather than “what”. This is a common occurrence for beginners and restricts the generation of alternative creative designs.

Domain knowledge is limited. In this case, outside help and other techniques will be required to generate ideas.

It is a good idea to keep concepts as abstract as possible and at the same level of abstraction. Do not generate concepts for the function of “move object” where one is given as “impact with another object” and another is given as “use an XYZ Model 1530 hydraulic cylinder”. It is difficult to compare functions at different abstraction levels.