

ME349

Engineering Design Projects

Function Development

Our next step in the development of our design is that of Function Development. The purpose of this stage is to generate a list of the “functions” that we intend our product to accomplish. Function is often referred to as the logical flow of energy, material, and information. For our purposes in mechanical design, we can expand this definition of function to “behavior of a human or of a machine that is necessary to accomplish the design requirements”. In the case of product development, function states “what” the product must do, whereas the form and structure of the product dictates the “how”.

Methods for identifying and cataloguing customer needs have been widely used for many years, methods for the generation of design concepts to meet those needs have typically been left to the whims of the design team. The transition from needs to solutions has been seen more as an art than as an accepted science. For many earlier products, the move from needs to solutions was based primarily upon the previous experiences of the design team. With shrinking development cycle times and budgets, this process has limitations. Most notably, the link between customer needs and design concepts are at best indirect. Customer needs become only a tool for the evaluation of concepts rather than a driving force of the development of concepts.

Over the past two decades, new methods have been developed that have focused on mapping customer needs to functional requirements. Concepts are then generated to fulfill these underlying functional requirements. There are a number of advantages to this method.

- 1) Emphasis is on “what” has to be achieved by a concept rather than “how” it is to be achieved. This allows *form independent* solutions to be considered.
- 2) Functions provide a basis for organizing tasks and processes.
- 3) The process of mapping need to function then to concept permits multiple solutions to be explored in parallel. “If one generates one idea it will probably be a poor idea, if one generates twenty ideas, one good idea might exist for further development.”

Many of you will find this to be one of the more difficult steps of the design process, yet it will provide a key step leading to the generation of a large number of high quality potential solutions.

The first step in this process should be the definition of the overall function of your product. Revisit your problem statement and make sure that this function agrees with the problem you are designing to solve.

The next step is much more involved. For this step we have to sub-divide or *decompose* the overall function into a set of sub-functions. This process is continued to decompose the sub-functions. The goal is to reach the most basic level of functions required for the product. Functions consist of a verb and a noun (for example, “secure tab”), although at the lower levels of decomposition, if the noun is the same for all functions, it is sufficient to simply specify the verb. Functions may be divided into three general categories. These are the flow of energy, flow of material, and flow of information. By considering these three categories you will find it easier to generate functions for your product. Below is a list that gives examples of the types and verbs associated with each of the categories.

Flow of energy:

Types: Mechanical, electrical, fluid and thermal
Verbs associated: transformed, stored, transferred, conducted, supplied and dissipated

Flow of material:

Type: Processes which change position or shape
Verbs associated: Position, lift, hold, move, translate, rotate, guide

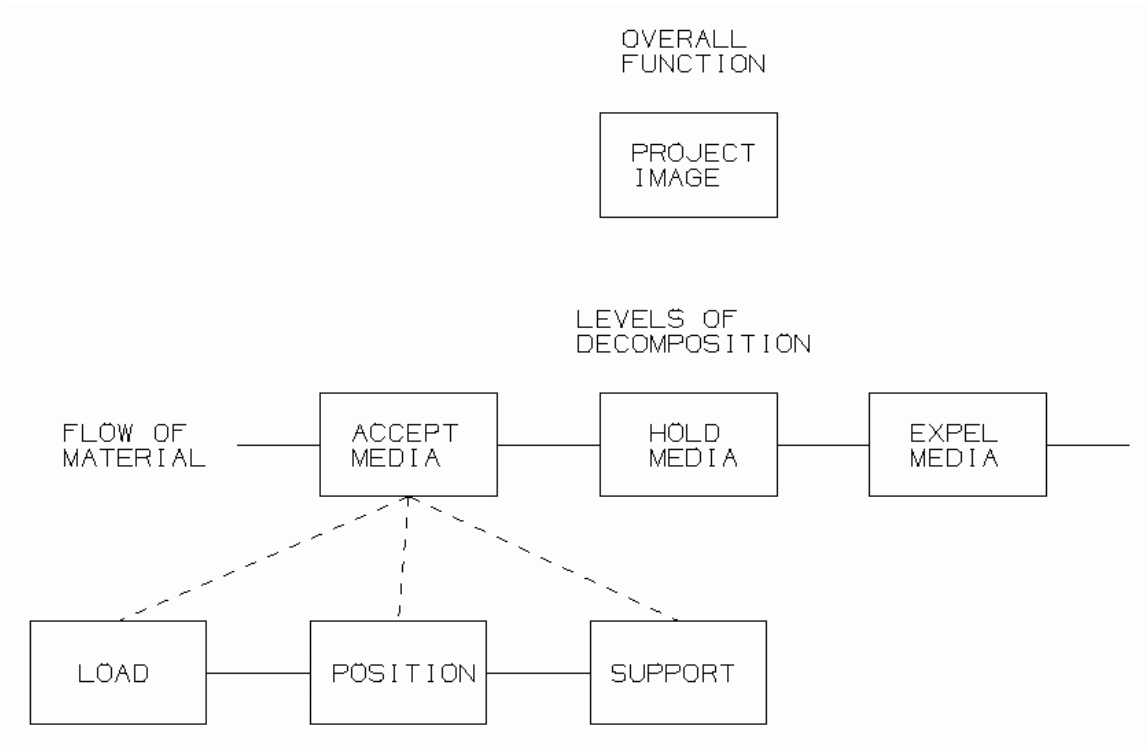
Type: Processes which divide material
Verbs associated: Disassemble, separate

Type: Processes that converge material
Verbs associated: Assemble, join

Flow of information:

Types: Mechanical and electrical signals, software
Verbs associated: Conduct, channel

The following figure shows the overall function and an example of decomposition of function for the Slide Projector Design that we examined earlier in class. The overall function of the product is given along with a first level function list for one type of material flow through the design. The first function of this material flow has been decomposed into constitutive components. This process would be repeated for the other material flow functions. Note the use of block diagrams. The use of block diagrams will help you to organize your functions and to reflect flow.



Below is a list of function verbs which may help you in the function decomposition of your product. Realize this is not an all-inclusive list and that your specific design may have other functions. Once you have created the function decomposition for your product we will use this to develop design concepts.

- | | | |
|-------------|-----------|-----------|
| absorb | grasp | separate |
| actuate | guide | shield |
| amplify | hold | start |
| assemble | increase | steer |
| avoid | interrupt | stop |
| change | join | store |
| channel | lift | supply |
| clear | limit | support |
| collect | locate | transform |
| conduct | move | translate |
| control | orient | verify |
| convert | position | |
| couple | produce | |
| decrease | protect | |
| direct | rectify | |
| disassemble | release | |
| dissipate | remove | |
| drive | rotate | |
| fasten | secure | |