12.1/12

TIM 105/205, Lecture #12 (11/5/13)

Agenda:

1. HW #5 (due on Thursday)

2. Product Conceptual Design Process

German Engineering:
- Function structure (FS) not to be confused with the FAST diagram
- Morphological matrix
  FORM
- Concept selection

HW #5

Language:

Function	Form
WHY? purpose	HOW? realization
provide power (car)	→ car engine
process documents	→ Word processor (MS Word)
function is useful in determing customer needs (SUBJECTIVE)	form is useful for determining technical metrics (OBJECTIVE)

function → provide power → Customer needs

form → car engine → technical metrics

Customer needs:
① ~~(high)~~ performance → Acceleration (m/s^2) (0-60 mph in x secs)
② ~~(high)~~ fuel economy → Miles per gallon

Read the chapters on

① Identifying Customer Needs
② Product Specifications (PS)

} in the U&E, PD&D text

HW #5, Problem 1
- Read chapter on PS in the text
- Lessons learned?
- How do you use the HOQ for the bicycle suspension fork?

HW # 5

Problem # 2 : Creating a HOQ for 2 products (from the list)

1. Create a process for creating HOQ

This process would combine
- Product Dissection (FAST) process → Lecture # 10, 11
- HOQ process → Lecture # 9

Example Word

Main function → Process documents

Sub-functions
- open documents
- manipulate documents
- save documents

"Sub-systems" and "components"
features (for software)
e.g. copy; paste;

do this dissection while using/playing with the product (MS Word)

for MS Word example of

Customer Need → Technical metric (during testing)

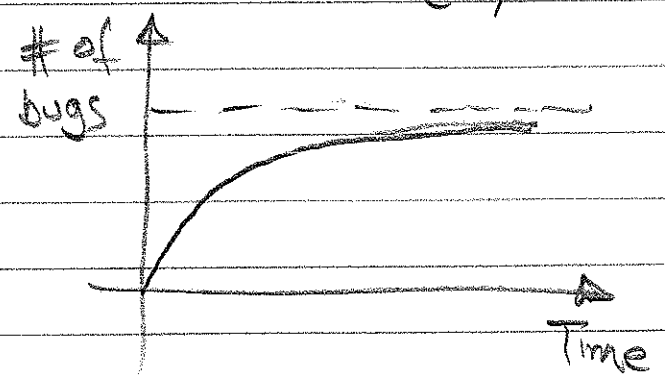
reliable (does not "crash") → "bug" count

"bugs"/week

Target specification

(Release product when)

bugs/wk = some specified # (say 5)



# of features

HW #3, Prob 3 : HOQ for

your intended new products

- Identify related products
- Reverse Engineer (Dissect) these products using FAST
- Create the HOQ for the new product

- Do team problem-solving
- Every member of the team must submit this (team) HOQ

Conceptual Design of New Products

Statement of the problem:

1. Generate several alternative concepts to realize a high-level idea for a new product.

   High-level idea: device for saving energy in the home

   : autonomous system (robot) capable of operating indoors (e.g. in a house)

2. Compare and assess these concepts relative to each other

3. Select one (or two) feasible concepts (designs) for further development

Basic ideas

(1) In order to develop several alternative concepts it is crucial to separate FUNCTION (WHY) from FORM (HOW).

⇒ Create an abstract functional representation of the product, called the FUNCTION STRUCTURE (FS)

(ii) No product is completely new

⇒ find existing products related to the intended new product, and reverse engineer these products

The process for Product Conceptual Design

Step 1: Establish customer needs & technical metrics/specifications for the new product using the HOQ

Step 2: Identify the main or primary function of the product (i.e., the product INTENT.)

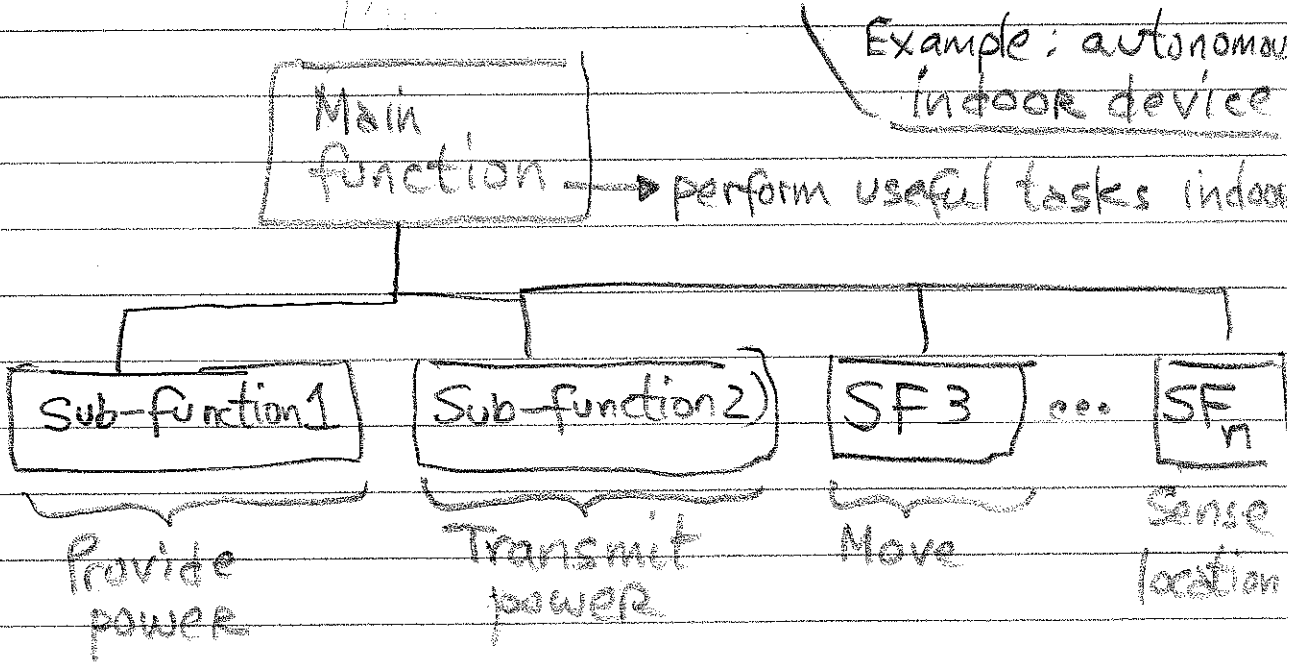
Step 3 : Identify one or more related products, and then reverse engineer (dissect) these products using FAST

(Step 3 could precede Step 1)

[Note: Steps 1, 2, 3, are done in parallel or concurrently.]

(See HW #5, Prob. 3)

Step 4 : Create an abstract functional representation of the new (intended) product, called the Function Structure (FS)



(See Chapter on Concept Generation in U&E, PDSD text; also FS handout on class web-site)

Step 5 (i) for each sub-function, generate alternative solution principles for realizing that subfunction

(ii) Organize the solution principles (SP_s) in a morphological matrix (MM)

[Zwicky]

Morphological matrix (MM) for the autonomous indoor device

(from research, creativity [brainstorming, ...] etc.)

Solution Principles → / Sub-functions ↓	Solution Principle 1 (SP1)	SP2	SP3	....
SF1 (Provide power)	Electrical	Gasoline	Solar	Wind ....
SF2 (Transmit power)	Gearbox	Hydraulic	Pneumatic (air)	.....
SF3 (move w.r.t. ground)	wheels	legs	air-cushion	.....
SF4 (sense)	vision	sonar	.....	
all other subfunctions	... ...			

1 2 3

Step 6: Generate 6-10 alternative concepts, by suitably combining the solution principles in the MM.

(See above: "zig-zagging" through the MM in a rational manner)

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Note: The first few columns of the morphological matrix would typically contain the results of dissecting related products (e.g., in this example products like the ROOMBA)

Step 7: Identify an appropriate set of selection criteria to assess/compare these alternatives, and use these selection criteria to construct a utility function (UF). UF will be used to compare & select from the alternatives

Step 8: Use the utility function (Step 7) to compare the alternatives generated in Step 6; and, then, select 1 (or 2) feasible concepts for further development (prototyping, etc.)

Useful references: The text U&E, PD&D

Chapter on "Concept Generation" (4th Ed., Chap. 6)
Chapter on "Concept Selection" (4th Ed., Chap. 7)