3. Designers and Design Teams

- Early designs – iterative improvement based on repeated prototypes
  - Longer time for perfection and mature designs
  - Knowledge to be gained by actual fabrication and testing
  - Knowledge passed on by apprentice programs
- Complex products cannot use the same procedures
  - Knowledge to be gained by other means

Human Information processing

- Information processing takes the interaction of
  - Internal environment
    • Human brain
  - External environment
    • Catalogs, paper and pencil, etc.
Human Information processing

- General knowledge
  - Gained through everyday experience and basic schooling.

- Domain specific knowledge
  - Comes from study and experience in the specific domain.
  - Formal education
  - It takes 10 years to gain enough specific knowledge in a domain.

- Procedural knowledge
  - Comes from experience.
  - But some may be based on general knowledge and some on domain specific knowledge.

Short term memory

- It is quick (0.1 second)
- Very small (7 chunks of information ± 2)
- Needs refreshing
Long term memory

- Unlimited capacity
- Slow (2 to 5 minutes)
- Speedy recovery (0.1 second)
- Retrieved at different levels of abstraction

"Wh, Olbrawn, may I excursis? My brain is full."
Controller

- Helps in allowing the information assimilation and utilization process.

External Environment

- Extend short term memory
- Making notes and sketches
- Sketches are fast to make and are information-rich
Implications of the model

- All design and decision making is limited by human cognitive capabilities
- What is to be done?
  - Breakdown problems into finer sub problems

Mental processed during design

- Understand
- Generate
- Evaluate
- Decide

Understanding the problem

- Design a joint to fasten together two pieces of 1045 sheet steel, each 4 mm thick and 60 mm wide, which are lapped over each other and loaded with 100 N.
- Retrieve the information from the long term memory and compare
Generating a solution

- To generate a solution we retrieve information from our long term memory if an earlier similar design was made.
- If the design is completely new, then we use the decomposition technique to solve it incrementally.

If you try to think about what you are doing while you are doing it, you stop doing it.
- If you don't reflect on what you just did, you are doomed to repeat it.

Evaluation and Deciding

- Evaluation requires comparison between generated ideas and the laws of the nature, the capability of technology and the design requirements.
- Once a problem is solved, a decision has to be made to accept the generated solution and go for another one.
Problem solving behavior

- Introvert
  - Listens, thinks and then speaks
  - Works alone to solve problems
- Extrovert
  - Sociable, speaks and then thinks
  - About 75% Americans are
  - About 48% of engineering students and top executives are
  - Extroverts

Problem solving behavior

- People dealing with facts
  - They are literal, practical and realistic
- People dealing with possibilities
  - They like concepts and theories
  - About 75% Americans are
  - About 66% of top executives are
  - About 34% of engineering students are
  - Fact oriented
- Design requires
  - Facts and possibilities

Problem solving behavior

- Decision making process
  - Subjective, or
    - Decisions based on interpersonal involvement, circumstances and the "right thing to do"
  - Objective
    - Logical, detached and analytical
  - About 51% Americans are
  - About 95% of top executives are
  - About 68% of engineering students are
  - Objective decision makers
Problem solving behavior

• Need to make decisions
• Decisive
  – Makes with minimum stress, and likes an
  environment that is ordered, scheduled,
  controlled, and deliberate
  – Tend to jump to conclusions
• Flexible
  – Goes with the flow, is flexible, adaptive, and
  spontaneous, and finds making and sticking with
  decision difficult.

Characteristics of a creative Designer

• Natural talent
• No correlation with intelligence
• Visualizer, a hard worker, and a
  constructive nonconformist with
  knowledge about the domain and the
  ability to dissect things in his or her
  head.

Fig. 3-5 Airframe of a small aircraft

Courtesy: David Ullman – Mechanical
Engineering design teams

- Complex products
- Boeing 747
  - 5 million components
  - 10,000 person years of design time
  - 3 years
- Design teams

Team goals

- A team is a group of people working toward a common understanding
- Team members should collaborate
- Team members must compromise
- Team members establish communication
- Team members are committed to the good of the team
Team roles

• Organizer or Coordinator
  – Mature, confident and trusting
  – Good at clarifying goals and promoting decision making
• Creator
  – Imaginative and can solve difficult problems
  – Impractical, have a disregard for protocol, and work with possibilities than facts

Team roles

• Gatherer
  – Good at exploring and developing contacts
  – Very enthusiastic, but may lose interest when the details are reached
• Motivator or shaper
  – Dynamic, outgoing and assertive
  – Impatient with vagueness
  – Makes logical and objective decisions

Team roles

• Evaluator
  – Intelligent and shrewd
  – Accurate judgments but not a leader
• Team worker
  – Avoids friction in a team and
  – Subjective decision maker
• Solver
  – Turns ideas into practice
  – Disciplined, reliable, and efficient
• Completer or pusher
  – Delivers results on time
  – Works with facts than ideas
Building Team Performance

• Keep the team productive
  – All members understand the purpose
  – The members feel it is exciting
  – The goals are clear, simple and measurable
  – The goals are realistic
  – The approach is clear

Building Team Performance

• Select based on skills, primary and secondary
• Establish clear rules of behavior
• Set and seize upon a few immediate performance oriented goals and tasks
• Spend time together
• Develop a common understanding
Summary

• All design and decision-making is governed by human cognitive limitations.
• If you try to think about what you are doing while you are doing it, you stop doing it.
• If you don’t reflect on what you just did, you are doomed to repeat it.
• A team is a group of people working toward a common understanding.

Questions and Comments