Short Course on
User-Centered Product Definition for Creative Engineering Design

SSSA Pontedera
5 March - 16 April
Course objectives, approach

**Objectives:** Introduce participants to some Stanford Design Group/d.School and Silicon Valley design methods used in early stages of designing a new product.

**Content:** Mix of introduced ideas and techniques + hands-on sessions

**Schedule:** Tuesday/Thursday, with break during last week of March + Easter

**Expectations:** Modest “compiti” between classes, to gather information, build prototypes. Some tools, materials are provided for class. Student teams are expected to add to these on their own.
User-Centered Product Definition for Creative Engineering Design

Instructor: Mark Cutkosky (+39 328 771 4566, cutkosky@stanford.edu). You can often find me in the laboratory of Prof. Cesare Stefanini.

Dates: 5 March - 16 April 2013. Class times are Tuesday/Thursday at 14:30, with a couple of breaks during last week of March (Cutkosky at Washington DC) and for Pasqua.

Detailed Schedule (PDF)

Location: Aula 1 + other rooms, as needed, at SSSA Pontedera

Description:
The objective of this short course is to give participants an introduction to some of the methods used in the Stanford M.E. Design Group, the d.School and design firms in “Silicon Valley,” to promote user-centered design. The course content is taken in part from the first quarter of a graduate design sequence at Stanford, ME310abc. and focuses on the early stages of product development, when the main challenge is to determine what to design. In ME310, teams of graduate students at Stanford collaborate with partner teams at various universities around the world to address problem statements provided by corporate partners. Specific methods introduced in the first part of the course include: structured brainstorming and design definition, user and technology benchmarking, persona development and critical experience and critical function prototyping.

For the purposes of the instructor. All product development

The course is recommended for graduate engineers interested in engineering design that addresses the (sometimes hidden) needs of users. Enrollment will be limited to 32 participants (8 teams of 4). Informally, it is also a prequel to the design course that Prof. Cesare Stefanini will be conducting this spring.

http://bdml.stanford.edu/Main/PisaShortCourse2013
Context: 50 years of project-based design

- **Creative Design** with John Arnold and GSB
- **Product Design Program** with Fine Arts Department
  - **Robotic Systems Design** with Computer Science and Aero
  - **Team-Based Systems Design (210/310)** with Corporate Partners
  - **Smart Product Design (218)** with EE and CS
  - **Center for Design Research (CDR)** with Industry Partners
  - **Manufacturing Systems Design** with GSB and MS&E
  - **Micro Electro Mechanical Systems Design (MEMS)** with EE
  - **Human Computer Interaction Design** with CS
  - **Learning Design & Technology** with Education
  - **Learning Lab** with Wallenbergs of Sweden
  - **BioDesign** with Biology & Medicine
  - **d.school** with HPI and IDEO
  - **venture design** with India & Nigeria

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Context: entrepreneurial design connections
addressed by IDEO co-founder, Prof. David Kelley

Design short course 2013
tangible communication
prototype storming
defying gravity
Stanford-IDEO
early design process

(re)Define the Problem

Design never ends

Needfinding and Benchmarking
Understand the users, design space

Bodystorming
Ideate

Prototype
Build

Test
Learn

(Continued)
Stanford-IDEO like design process ... in reality

(re)Define the Problem

Design never ends

Needfinding and Benchmarking

Understand the users, design space

Prototype

Build

Bodystorming

Ideate

Test

Learn
Background: Two kinds of project courses

- Projects specified by instructor
- Pedagogically inspired
- Everybody does same project
- Content introduced *Just in Time*
- Results:
  - Effective content injection
  - High enthusiasm
  - Potential for overload
  - Organized
  - Sometimes unclear if “real world”

- Projects taken from outside (e.g. industry)
- Every project is different
- Process introduced *Just in Time.*
- Results:
  - Real world
  - Mixed enthusiasm
  - Potential for overload
  - Sometimes seen as “not organized”
ME310 Project-based learning

I hear and I forget.
I see and I remember.
I do and I understand.

Confucius

Me310 is about forming and running creative, productive, engineering design teams. It is also about “the Design Division philosophy” of engineering design. It is the quintessential project-based learning (PBL) course:

• see and hear
• do and experience
• reflect and introspect
• document for the future
Autumn
explore the problem space

Winter
explore the solution space

Spring
deliver a functional product

Whatever it takes to get it done (testing, refinement, manufacturing)

30 weeks

Corporate Projects Start

Paper Bike Design Exercise

Benchmarking Prototypes

Critical Function Prototype

Darkhorse Prototype

Funky System Prototype

Functional System Prototype

Autumn Winter Spring Presentations & Documentation
Typical project development

Fall: Make it up
Winter: Make it Real
Spring: Make it Happen
tangible access to each other
maker space
Where does the project come from?

Traditional Engineering -- A *problem* looking for a *solution*…

“We have this interesting problem and hope that you can design something that provides a solution to it.”

Successful but limited innovation…
Where does the project come from?

- Technology Push -- A **solution looking for a problem**…

  “We have this interesting new sensor (or actuator, or material, or display, or...) technology and we hope that you can design something that will make use of it and help create a market for it.”

Innovative, but limited success…
Where does the project come from?

- **Needs Pull:** “We think there may be an opportunity to design something that improves the experience of…”

Successful and innovative!
The car adapts, so that from the driver’s perspective it is better after one year than when he bought it.

The car helps the driver to drive better, with greater safety, skill and enjoyment.

Like a prized horse and rider, they are a symbiotic team, driving better all the time.
Traditional Engineering Design Process

Needs-based Design requires a new design process
Needs-Based Engineering Design

investigate needs

But wait…
What are needs?
How do we investigate them?
Stanford ME310 - Fall quarter topics
(topics especially useful in the early stages of design projects)

1. managing creative distributed teams
2. need-finding and concept development
3. physical and functional prototyping for design discovery
4. defining, discovering and refining requirements
5. documenting and clarifying the design and its rationale
6. user testing and concept analysis, experience benchmarking
“Deep Dive” Video

IDEO design process

Look for:

- identifying needs/opportunities
- benchmarking, researching
- brainstorming
- building early prototypes to help define requirements
Opportunities for Market Discovery and Creation

Needs-Based Engineering Design

- build
- investigate needs
- determine requirements
- analyze
- design
- build
- refine
- test

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But companies have solutions and they want to create markets and products for markets...

So how does it really work?

possible solutions

Establish needs

Define:
- Requirements
- Assumptions
- Opportunities

design

refine

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Example #1: Intel Intellicare

- Intel Corp. has microprocessor solutions for wireless applications.
- What groups of people have needs that might create market opportunities for such devices?
- What products and markets might develop around these needs?
- What designs could help define a market?
Phases of Aging – iCare Focus

- Cost
- Independence
- Caregiver Effort
- Ease of Social Interaction

Unmonitored Living  | Monitored Living  | Constant Care Facilities
**IntelliCare: persona development**

**How:** Based on user interviews, benchmarking (literature + social services, etc.)

**Why:** promotes attention to detail that makes a design truly meet users’ needs

**Figure 11: Mary and her son Jeff**

This scenario was developed by the members of team INTELiCare. It serves as a situation that the team used to design around. The situation is intentionally designed to be simple, so the initial system design may be straightforward and less prone to complication.

Meet Mary and Jeff. Mary is an 88-year old widow who lives independently at her home. She is in good physical health, but is becoming more forgetful as her age increases. Additionally, she has become more isolated, resulting in decreased physical and social activity levels. Mary’s son Jeff becomes increasingly concerned as he notices decline in her activity levels and mental sharpness. When the need arises, Jeff will act as Mary’s primary caregiver, since he is her
IntelliCare: context framing, benchmarking

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Various prototypes from Stanford and Sweden (KTH)

prototypes of caregiver ambient display (shape change & vibration)

prototype of elder unit (pendant)
Example #2: Panasonic

Develop innovative “hands free” solutions for interacting with personal devices (smartphones, MP3, bluetooth headset, etc.)

• Team identified problem: unobtrusive control of devices, calls, etc.

• Team identified solution: use “teeth click” and head tilt as control inputs
example #3: Satellite Manufacturing

Need-find, conceive, build-test
re-invent the physical architecture
of communication satellites
for Lockheed Martin
with Cali Columbia in 2011-12
current user architecture
current user architecture
Creating *personas* helps to ensure that user needs and desires are addressed.

Based on interviews at Lockheed and Loral:
- Enthusiastic, active.
- Likes space domain.
- Detail oriented, neat.
- Doesn’t like documentation.
- Doesn’t like disassembly and rework...

**meet Kevin**
keeping the user in perspective
giving him a decent working space
me310 example #4
need-find, conceive, build-test
re-invent the nursing home experience
for Swedish Welfare Agency with Lulea SE 2006
benchmarking
Revisiting those “tools for early stage design”
(What have we seen examples of?)

1. managing creative distributed teams
2. need-finding and concept development
3. user testing and concept analysis, experience benchmarking
4. defining, discovering and refining requirements
5. documenting and clarifying the design and its rationale
6. physical and functional prototyping for design discovery

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design is all about people
Team Analysis (Wilde*/Jung/Myers-Briggs)

At any moment a person can be

- Perceiving ↔ Judging

Perception can be through

- Sensing ↔ Intuition

Judging can be based on

- Feeling ↔ Thinking

Any of these modes can be used in two ways:

- Extroverted ↔ Introverted

When faced with a design challenge my first preference is to...

take some time to think about the problem, perhaps sketching ideas, or making notes. My best ideas often come to me when I’m in this reflective mode.

talk to people, look things up, go places, and get as much input as I can. I find that my best ideas are often triggered by external interactions.
Example #5: Getting closer to the inspiration of this short course...
Design something that will represent a new potential market for **Gorilla Glass**

- **Corning**
  - Materials Manufacturer
    - Pyrex® - heat resistant glass (beakers, test tubes, etc.)
    - Corning Ware® - kitchen-grade glass ceramics (baking trays, etc.)
    - Low Loss Optical Fibers
    - Gorilla® Glass - fusion process, ion-exchange, strength, no scratching
  - Products in many markets
    - Display technology, Telecom, Environmental
    - Specialty Materials (Gorilla®)
  - Fundamental Research (Materials and Processes)

- **Gorilla® Glass**
  - 2X strength at 1/2 the thickness
  - Scratch and abrasion resistant
    - 30x more than plastic
    - 5x more than conventional glass
  - Thin and strong
    - 0.5mm to 2.0mm thick
    - Flexible
  - Order of magnitude more expensive than ordinary soda-lime window glass