Radical Design
Spring 2009
From pencils to clothing to processes to software
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Course Objectives
• Introduction – why the course?
  • Introduction
    – faculty
    – each class member
• Preamble to course
• Video/hands on exercise
• Problems with software today
• Glimmers of hope
• Homework

Course Objectives
• To have you learn to perceive (hear and see) and imagine
  – Note that this is different than listen and look
• To have you learn how to think creatively and out of the box
  – There are techniques that help
• To have you learn how to design and develop new objects
  – With the goal of applying this to software and hardware products
• To have you learn creativity management techniques

Why the course?
• Software is in a crisis
• Software tools and systems are too complex
  – For programmer
  – For end-user
  – For experimentation
• Developers (you) are expected to build increasingly complex software systems

Why the course?
• Time to think radically, not just evolutionarily
• When asked to develop something new, programmers often take a piece of working code and modify it – this is evolution
• What we want is revolution and simplification
  – Dramatic new capabilities
  – 10 lines instead of 1,000
  – 100 lines instead of 10,000
Preamble

- Creative and breakthrough applications often arise from the combination of computing resources from multiple, conflicting domains
- A new approach is needed to allow teams of designers — some software engineers, others subject matter experts — to combine their expertise in the design of products based on large, heterogeneous software systems
- Knowledgeable creativity, agile development and flexible personnel management are necessary today to realize these complex continually evolving new products

Preamble

- There is a wealth of knowledge and experience in creative product design
- This course will encourage you to think and work creatively in creating radical products
- The main goal is to have you acquire and develop the knowledge, insight and expertise in the radical development process for new objects

Radical Design Topics

- Creativity Methodologies
  - Over 20
- Creativity Techniques
  - Over 200
- Creativity Management
  - Individual or Organizational
  - Striving for Innovation
  - Dealing with constraints and blocks
  - Creativity as an Evolutionary Process

newIdeas = f(oldIdeas)

Generativity Basics

- Competing behaviors (ideas, thoughts, actions) are in constant competition thereby producing a steady stream of new behaviors
- New ideas emerge as old ones compete and this combinatorial process is orderly and predictable
- By influencing the type and number of competing behaviors we can accelerate the creative process and direct it toward useful end

Implications

- Everyone is creative
- Creative people have special skills
- Anyone can learn such skills
Lots of Different Strategies for Enhancing Creativity

- Example
  - Capturing
  - Challenging
  - Broadening
  - Surrounding

Myths about Creativity

- It’s rare
- Only artists have it
- Only high IQs have it
- You need to hire it
- It’s in your right brain
- It’s mysterious

Fall 2006 Course had 3 parts

- First group activity
  - Identify and design a radical product (pencil, paper, clothing, …)
- Mid-term
  - Design and implement a radical multimedia presentation that can be used for marketing (1min)
- Final project
  - Design a radical software API for your product (language, object, UI, …)
  - (Pseudo) code a typical use of the product and an atypical use (remember: about 10 lines of code)

Some of the lecture titles

- What is radical design?
- Theories of creativity (person, process, idea) and metrics
- Practical techniques (some with solid foundations, some with false foundations)
- Creative, innovative, radical products: how do we attain these?
- Multimedia techniques
- Intro to Unified Modeling Language (UML)

Example Student Projects

- I/O Headset
  - Functional brainwave mappings for mental control of computers
- SafeTran
  - Carless city security software/hardware system
- Chew-n-Clean
  - Tooth cleaning nanobots

Chew-n-Clean
Student Project Materials

Next Generation Dental Hygiene and Oral Cleansing System
Oral Hygiene
Current Problems

Problems with Current Approaches:
• The toothbrush alone is an incomplete cleaner
• Floss is effective between teeth, but few people use it regularly (our interviews also confirmed this)
• The toothbrush requires proper technique
• Toothbrush & Floss: not truly assistive technology
• Many people do not brush frequently enough or long enough
• Also:
  • Are flossing & expectorating culturally sensitive?
  • What about regions/areas where toothpaste, fluoride, and floss are non-existent or in short supply?

Vision

Imagine: a lifetime of great dental health and oral hygiene without brushing or flossing your teeth – ever.

That possibility will be made a reality with Chew-n-Clean and Wash-n-Brush: the next generation dental hygiene and oral cleansing systems.

The Chew-n-Clean Difference

Key Benefits

Universal Access:
• Active ingredients in chewing element or wash; accessible to young, old, disabled

Cognitive Design:
• Uses natural chewing or rinsing motion; anyone who can chew or rinse can use the device

Tolerance for Error:
• No special technique or training needed. Also, materials used are non-toxic if/when swallowed

Effective:
• Cleans surface of, in-between, and behind teeth
• Eats away plaque and tartar; Whitens teeth and sterilizes your mouth

Culturally Sensitive & Ecologically Friendly:
• Gum or Mouthwash available
• Designed to be swallowed, if desired
• Can have a variety of flavors, including no flavor

Chew-n-Clean
Usage Model

Application:
• User chews on chewing element, or inserts ¼ cup of liquid into mouth. User chews for two minutes, or swishes for one.

Action:

Outcome:
• Clean teeth, fresh breath. Liquid and chewing element can then be expectorated, or swallowed for a nutritious meal!

Student Marketing Presentations

• Chew and Clean TenSecPresentation.wmv
• Chew and Clean trailer2.mov
• Chew and Clean Comic Book
Final Project: Chew-n-Clean API Description

- API used mainly by a nano-dentist, trained in nano-dentistry, to customize the gum for the particular patient.

- Gum could be purchased from a standard store, but does not work without being placed into a user’s gum programmer, which acts as an activator and settings manager for the gum.

- This device (which is a small powered box that the user places a certain amount of gum to be programmed into), can also be purchased at a store, but must be set by a nano-dentist for customization to the user’s mouth.

- The patient goes to a dentist, who uses the gum and their own programmer/controller to determine what settings are appropriate for the user. Once these settings have been chosen, they are emailed to the user as an encrypted file that can be downloaded to their own gum programmer providing the user with their own custom gum.

Chew-n-Clean API Description

- The gum contains UV Bots, which emit UV light, Friendly Bacteria, which eat food particles and plaque from on and between teeth, and Sensor Bots, which travel around the mouth and monitor things about the tongue, teeth and gums, as well as broadcast this data in an encrypted format wirelessly (using a protocol such as Bluetooth) to devices that can read from such a protocol.

- The devices that can use something such as Bluetooth (computer, cellphone, etc), must use the user’s unique decryption key in order to read the data, so it cannot be read by sources that the user does not want to share the data with, such as market researchers.

- This sensor data can be used by programs on such devices in order to monitor health, and give suggestions about whether the user appears sick, or whether they should eat more fruits and vegetables. The sensor bots are also used to emit the flavor in the gum, the reason being that they can be reprogrammed to change flavor more easily than reengineering bacteria.

Activity Diagram

- Shows all possible interactions from a user and their respective outcomes.
- In any scenario, the start state is a login screen, and the final state is when a user exits the API.

Sequence Diagram

- Six major components to the API, that being the Dentist (User), Controller (handles all UI events), the Bacteria, UV Nano Bots, Sensor Bots, and a Data Receiver (typically a Bluetooth device to receive sensor data).
- Here we can see the flow of a failed and successful login, setting parameters of the components, as well as making diagnostic calls to the sensor bots.

Course Evaluation

- Success from the students and faculty

However:

- Products were overly futuristic
  - Five year timeline was too long

- API design was too easy
  - Purely theoretical
  - Not practical/realizable enough
  - Pseudo-code only
Spring 2007 Course

- Taught with 3 instructors
  - Me
  - Fred Martin
  - Sarah Kuhn
- Products were less futuristic
  - Shorter timeline
  - Realizable in a few months to one year
- API was real and practical
  - Actual working code, not just pseudo-code

Group 1 Project: Workstation

- Thoughts and Discussion
- Competitive Product Survey
- Still Photo Survey
- Extreme User Interviews
- Bodystorming
- Forecasting Matrix
- Attribute Dependency Template
- Replacement Template
- Presentations
  - Venture Capital
  - Environmental

Group 2 Project: OmniPhone

- Here’s their VC Presentation
- (they also had an environmental impact one)

OmniPhone

- An all-in-one integrated hearing device with the capability to tap into virtually any electronic audio signal
- The comfort and convenience of listening tools customized to the individual
- The added protection against environmental hazards
- Leverages existing Bluetooth & cell phone technologies
- Reduced noise pollution
- User controllable protective settings
- Cautionary alarms and infinite possibilities via open-source processing approach

The Problem:

Tapping the explosive growth of available electronic audio signals requires a multitude of listening devices

- none of which offer a comprehensive solution to personal hearing needs.

The Implementation:

- Fits mostly within ear, much like an earbud or in-ear hearing aid
- Protects against outside noise via ear protection
- Takes sound in via mic, processes through DSP and wireless Bluetooth communication and out speaker to user
- Advanced processing of audio signals done via Bluetooth on external device, such as cell phone or PDA
The Implementation (2):

- Software for Bluetooth device (such as cell phone or PDA) can be written by anyone and sold to consumers.
- Provides constantly upgrading audio processing software – As well as a market for vendors to provide software to the device.
- Replaces headphones, cell phone headsets, hearing aids, hearing protection and many other devices.

The Market:

- Already an explosive growth in both sources and consumption of audio:
  - **Signal Sources**: iPods, XM and SIRIUS Satellite Radio, ESPN, msnbc, $3B in sales of 22.5 million iPods in 2005 alone.
  - **Listening devices**: cell phones, iPod ear buds, laptops, headsets, telephones - WW market for cell phone devices of 800 million units in 2005.

The Channels and Competition:

- **Channels**: retail outlets; web sales; cell phone service carriers.
- **Competition**: includes headset manufacturers (Sony, Sennheiser, Plantronics).
- **Partnerships** with manufacturers of PDAs and cell phones.

Timing and Return on Investment:

- Requires patience of three years to build awareness and demand – cash consumption of $5M to cover expenses.
- Two more to become profitable - $5M additional cash burn.
- Five to seven years in total – Valuation of $50M by year 5; $100M by year 7.

Exit Strategies:

- **Early** (pre shipping product): sell IP to other companies in the market.
- **After market acceptance**: Acquisition of brand company.
- **After market leadership established**: Acquisition (likely) or IPO (less likely).

Part of their process steps.
Forecasting Matrix

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<th>Size</th>
<th>Power Use</th>
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Group 3 Project: Green Toilet

- Interviews
- cold seats
- sanitation, especially the seat and self-cleaning
- ease of cleaning
- perceived cleanliness is of the utmost importance
- people don’t want to touch things
- the bathroom should not be wet
- toilet should not “close the bathroom”
- a separate toilet room
- Smells

Notes

- 3 of 14 say they are extreme toilet users
- i found this particularly insightful: “Name something your toilet doesn’t do that you would like it to.
- Automatically sense when a courtesy flush is needed or flushes before it clogs the toilet.
Pyramid Model

- Micro API
- Default States
- Merged Technology APIs
- Set of Base Product APIs (B₁, B₂, ..., Bₙ)
- Base Products

The Base Products

- Complete APIs for diverse products
  - Logo microworlds
  - GIS systems
  - Google maps
  - TiVo
  - Online news
  - Mobile APIs
  - Sensors
  - ...

MicroAPI

- Domain specific API tuned for implementing a specific focused real-world products
- 10 or so commands and few parameters
- End-user programmable

Merged Technology API

- Merger of all the base product functions minimally necessary to run new product
Default States

- Supports parameter changes to the default API
- Negotiates between the merged APIs and the microAPI

MicroAPI is a Generative API

- The microAPI can easily implement not just the radical product it was designed for but a range of non-anticipated other products
- Of course this is hypothetical and will be tested in the new course
- Clearly there are SWE issues but we believe this will work
- There are examples of such simple APIs
- The burden is on the middle layers for this to work

Course Activities

- Explore (r)evolutionary trends in design (e.g., pencils, APIs, embedded systems, or clothing), especially designs that combine hardware and software
- Evaluate several existing designs, and explore how both designers and consumers can participate in the development of more usable products and environments
- Explore case studies of such technologies in order to identify key elements and opportunities required for successful innovation.

Course Activities 2

- Review the fundamental principles of design by looking briefly at its history
- Look at the design process and explore innovation in various technologies
- Define new approaches for breaking ground with designing objects
- Look especially at changes due to the effects of, and responses, to revolutionary and often disruptive technology

Projects and Assignments

- These will include the analysis of a breakthrough product, a deep-dive into various software and hardware APIs, and the development of a radical product prototype
Part 1: Design and the Creative Process

- In the first 5 weeks of the course, we will have weekly readings, assignments, and class discussions to debunk common ideas about creativity (e.g., *more creative ideas generate more useful ideas*) and introduce new ones (e.g., IDEO’s design process)
- Assignments will include for example reviewing an award winning product, conceptualizing a new radical product and producing a 1-minute *elevator* talk multimedia presentation of that product

Part 2: Deep dive into Hardware and Software APIs

- An aspect of the strategy for radical design is the composition of diverse software and hardware APIs
  - Google Maps, TiVo, GPS, PayPal, sensor networks, mobile computing, database search, GIS, telephony, LabVIEW, online news, or home monitoring and others
- You will choose one or several of these APIs and become fluent with it (them)

Part 3: Design the Radical Product

- In a small-group format, you will design a new radical product
- Your team will select for its design a highly innovative specific technology demo around a particular theme of interest (e.g., bioinformatics, GIS) which will involve merging 6 to 8 of the base technologies from the above set of base product APIs
- This design process has similarities to mash-ups, though mash-ups often involve one API + another source of data, and these radical products will involve 3 or more such entities

Part 4: Implement it

- In the last 4 weeks of the course, you will build your radical product to prototype stage

Part 5: Generalize it

- In the last week you will design a generative, micro-API based on your invention (see position paper) that takes your radical design in directions you never imagined

Demonstration

- This final prototype and its micro API will be demonstrated in a class open-house near the end of the semester
Exercises

Modified from Robert Epstein and from Sarah Kuhn

1.1: Capture a Daydream
- Daydream for a few minutes

1.2: Capture a Daydream
- Daydream for a few minutes
- Jot down what you just experienced

1.3: Capture a Daydream
- Daydream for a few minutes
- Jot down what you just experienced
- Discussion
  - Did anyone leave this room?
  - Did anyone experience anything that could not possibly real (for example, upside down Eiffel tower, strange noises, bizarre images)?

1.4: Capture a Daydream
- Daydream again for a few minutes

1.5: Capture a Daydream
- Daydream again for a few minutes
- Jot down what you just experienced
1.7: Discussion

- Did anyone leave this room?
- Did anyone experience anything that cold not possible real (for example, upside down Eiffel tower, strange noises, bizarre images)?
- Did anyone have any difficulty? Why?
- Could the present conditions be the problem?
- Does daydreaming have any practical value?
The Srtcdjgjklered Game

Using the nonsense words
in the following slides
pronounce the word

Words

okccekjalsfjeejenc
ynnwhilzokooeodwshsqd
voenslwugawnejhslree
wovnensownghisdyehslei
awynvmroheaehseralsjer

The Srtcdjgjklered Game

Using the nonsense words
in the following slides
Each person will tell a story in sequence

Word 1

okccekjalsfjeejenc

Word 2

ynnwhilzokooeodwshsqd

Word 3

voenslwugawnejhslree
Discussion
• What did you notice?
• Did the ambiguous stimuli force you to be creative?

Creative Drawing
• Draw a representation of google
• 3 minutes
• Observe yourselves through the 3 minutes

Creative Drawing 2
• What did you notice?
• What does this tell us about the creative process?
Creative Drawing 3

- Select a neighbor
  - One of you is critic
  - The other is recorder
- Critic: review their drawing
  - For 1 minute be very critical
  - For 1 minute be very constructive
- Recorder: write down both + and - criticisms

NO QUESTIONS

Creative Drawing 4

- Comments?

Creative Drawing 5

- Comments?
- Note that specific roles help set activities quickly into motion
- What is easier + or – criticism?
- Note that modern civilization encourages negative criticism

Homework

- We need to learn about product design
- One way is to look, ask, explore, ...
  - Old products
  - New products
  - History of products
  - ...

Product Design Examples

- Examples of some interesting products
- Examples of some wild products
- Examples of some useful products
- Examples of some radical products

Product Design Process

- Know your product
- Know its history
- Know its evolution
- Know its users
- Know its environment

- Then, and only then, can a product (r)evolution take place
Homework 1 due 2-11-09 (page 1)

- Browse and experience the web for “radical materials” (around 4 hours)
- Who talks about radical design?
- Who teaches it?
- Where does radical design fit, how do people think about radical design, the process, product design, how do people work with design?

Homework 1 due 2-11-09 (page 2)

- Select a field of interest and after some experiences with web pages in the field, attempt to select a specific product of interest (eyeglasses, a can, a watch, a living room, a table, a computer, a book, a theory)
- Don’t rush it. It should be an object you are interested in and perhaps related to your state (are you renovating, are you looking to purchase a car, is your teenager going to get braces, are you getting married, …)

Homework 1 due 2-11-09 (page 3)

- Critically examine the product: how do people use it? What is the object’s relationship to its use? How do people relate to the object (aesthetic, usability, utility, engagement, …)?
- Explore its past, its evolution, its design, its future, and whether there is the potential for a radical step
- This is important before we break into groups for a single product/object activity

Homework 1 due 2-11-09 (page 4)

- Let your intuition and feelings flow with the web
- Write up 5-10 pages on your findings
- We will discuss your selected objects, identify obvious object groupings, and think about what product analysis and design groups we will form. The product you select may not be the one that the groups will select to work on. We will have 3-5 groups.

Homework 1 due 2-11-09 (page 5)

- The course web page is up for you to set up your personal wiki for the course
- Place your first HW assignment there
- Place any additional resources, papers, pictures, etc... you deem related in a universally understandable (possibly hierarchical) manner

Readings 1 due 2-18-09


Links

• Class Wiki
  http://www.cs.uml.edu/radical-design

• Lots of pages of modern designs
  http://www.core77.com/
  http://www.businessweek.com/innovate/
  http://www.library.cmu.edu/Research/Arts/Design/Everyday.html

Required Text

Creativity in Product Innovation by Goldenberg and Mazursky

Suggested Texts

1. Any good book on product design examples
2. The Art of Innovation by Tom Kelley
3. Hackers and Painters by Paul Graham (on line)
4. Any good book on design history
   Design of the Times by Bhaskaran (preferred)
   OR
   Design by Hauffe
   OR
   History of Modern Design by Raizman OR...