The Joys and Pains of Designing

ECE1799

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A Term 2013
Outline

• Personal Background
• Application: Medical Imaging
  – Quantitative Fluorescence Microscopy
• Creativity in ECE Design
  – Creativity framework
• Design of Precision LED Driver
  – Challenges
• Conclusion
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Personal Background

1979  Start college to study computers
1980  Change major to physics
1981  Change major to electrical engineering
1982  Work co-op job as "real engineer:" I can do this!
1983  Graduate with A.B.; look for job during recession
1983-86 Design engineer; Analogic [Wakefield, MA]
1986-90 Eng. Manager; Adaptive Optics Associates [Cambridge, MA]
1990  Enter Ph.D. program at University of Rochester
1991  Advisor at UR fired, transfer to Boston University
1994  Graduate with Ph.D.; look for job during recession
1994-? Professor at WPI
2002-3 Sabbatical; Analog Devices [Wilmington, MA]
2010-11 Consultant; 89North [Burlington, VT]
You need to be **flexible** to succeed!
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Fluorescence Microscopy

Endothelial cells under the microscope. Nuclei are stained blue with DAPI, microtubules are marked green by an antibody bound to FITC and actin filaments are labeled red with phalloidin bound to TRITC. Bovine pulmonary artery endothelial (BPAE) cells

http://en.wikipedia.org/wiki/Fluorescence_microscope
Quantitative Fluorescence Microscopy

Human lymphocyte nucleus stained with DAPI with chromosome 13 (green) and 21 (red) centromere probes hybridized (Fluorescent in situ hybridization (FISH))
Fluorescence Excitation Light Source

Needs:

• Precision
  – Accurate to 0.01%, time scale msec-to-days

• Speed
  – Settle to accurate value in ≤10µsec

• Power
  – Drive 100W (25A @ 4V) ultraviolet LED

• Efficiency
  – Goal 90%

• Size
  – Fit in ≤ 10 in³

No room for relaxation!
Stability: Metal Halide Lamp
Stability: LED

- Real time intensity feedback built into each module ensures consistent output over lifetime – essential for both short term and long term quantitative imaging experiments.
• Need to draw on all areas of ECE!
ECE Course Chart

• Pain of Designing:
• What happens when you haven’t taken ECE2312?
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Career Classification

CREATIVE
- ARTIST
- POET

USEFUL
- PROFESSOR
- TEACHER
- NURSE
- DOCTOR

ENGINEER

GOOD PAY
- ADVERTISING
- LAWYER
- STOCKBROKER
Why be creative?

• Need
  – Easy problems solved already
  – Tough problems need creative solution

• Dealing with environment of change
  – Coping, thriving

• Human nature
  – Fun!
Creativity Resources

A Whack on the Side of the Head

How You Can Be More Creative

A Kick In The Seat Of The Pants

Using Your Explorer, Artist, Judge, & Warrior To Be More Creative

Roger von Oech

Illustrated by George Willett
Creativity Framework

Explorer

Artist

Judge

Warrior
## Creativity Framework

**Explorer**
- Seek out new information
- Survey the landscape
- Get off the beaten path
- Poke around in unrelated areas
- Gather lots of ideas
- Shift your mindset
- Don't overlook the obvious
- Look for unusual patterns

**Artist**

**Judge**

**Warrior**
Creativity Framework

Explorer
- Create something original
- Multiply options
- Use your imagination

Artist
- Ask what-if questions
- Play with ideas
- Look for hidden analogies

Judge
- Break the rules
- Look at things backward
- Change contexts

Warrior
- Play the fool
## Creativity Framework

<table>
<thead>
<tr>
<th>Role</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explorer</td>
<td>Evaluate options, Ask what's wrong, Weigh the risk</td>
</tr>
<tr>
<td>Artist</td>
<td>Embrace failure, Question assumptions, Look for hidden bias</td>
</tr>
<tr>
<td>Judge</td>
<td>Balance reason and hunches, Make a decision!</td>
</tr>
<tr>
<td>Warrior</td>
<td></td>
</tr>
</tbody>
</table>
Creativity Framework

**Explorer**
- Put decision into practice
- Commit to a realistic plan
- Get help

**Artist**
- Find your real motivation
- See difficulty as challenge
- Avoid excuses

**Judge**
- Persist through criticism
- Sell benefits not features
- Make it happen

**Warrior**
- Learn from every outcome
Example: Time (Stages of a Project)

- Explorer: Background Research
- Artist: Brainstorm Options
- Judge: Choose Solution
- Warrior: Implement Design
Why a Creativity Model?

Education
• Standardized-test-numbed students
• Paralysis in face of open-ended problem

Designer
• Awareness of strengths, weaknesses
• Recognize preferences

Not Right or Wrong!
• One way of looking at process
• Orchard analogy
Example: Modes of Thinking

Explorer

Artist

Judge

Warrior

Divergent
- Soft
- Qualitative
- Add Complexity

Convergent
- Hard
- Quantitative
- Eliminate Complexity
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Challenges

• A vs. D? Gather Lots of Ideas

• LED Evaluation: Explore the Landscape

• Power stage: Get Help

• Stability Feedback Theory: Evaluate Options

• LED Switching: Difficulty as Challenge
LED Evaluation

http://www.luminus.com/products/uv.html
Feedback Stability

- Simulated performance
LED Switching

- Meets 10µsec speed requirement
Joy of Designing
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Conclusion

• Flexibility
  – Needed for success!

• Creativity
  – Needed to solve challenging problems

• Electrical and Computer Engineering
  – Wide range of tools to choose from
    • Analog, digital, signals, power, …
  – Solve problems to meet people's needs
Acknowledgments

• 89 North
  – Hugh Spahr
  – Julie Martin
• Texas Instruments
  – Peter Miller
• Creativity Resources
  – Roger von Oech