

On the Peculiarities of Design: An Engineering Perspective

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1.Introduction

- Our Interaction with **Design** is Frequent!

Hear



Talk



Ambiguous ... Obscure



Not Trivial!!!

See



Do!!



Transfer of
Knowledge?!?!?!?



1.Introduction ...

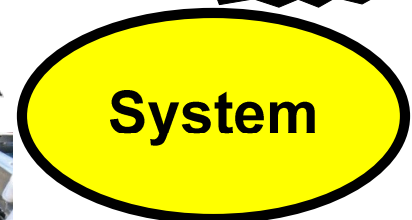
■ What about **Engineering Design (ED)**?

■ Purpose of ED will vary for each:

- Discipline
- Abstraction



Engineers



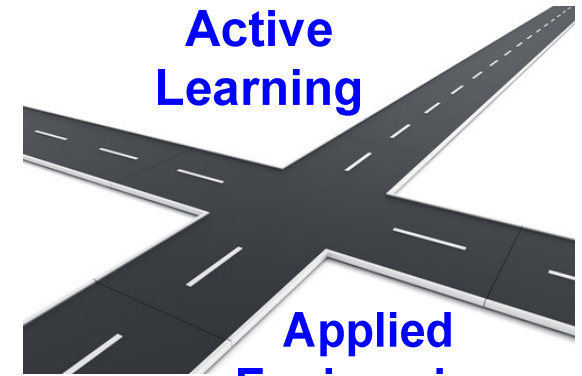
Big Picture

Reforming Eng. Education



CONCEIVE DESIGN IMPLEMENT OPERATE

Active Learning



Applied Engineering

1.Introduction ...

- Objective: **Dissect + Reflect** on the idea of **Design in Engineering**.
- What are the Attributes of Design?
 - Diversity of Design
 - Complexity of Design
 - Elements of Design

2. Understanding Design

- No Explicit Definition!!!
- Open for interpretation:
 - Scientific viewpoint
 - Philosophical viewpoint
- Body of Knowledge on ED:

But we want a “practical” understanding of ED

WHY?

Simplify its “teaching” and “learning”



and many more ☺

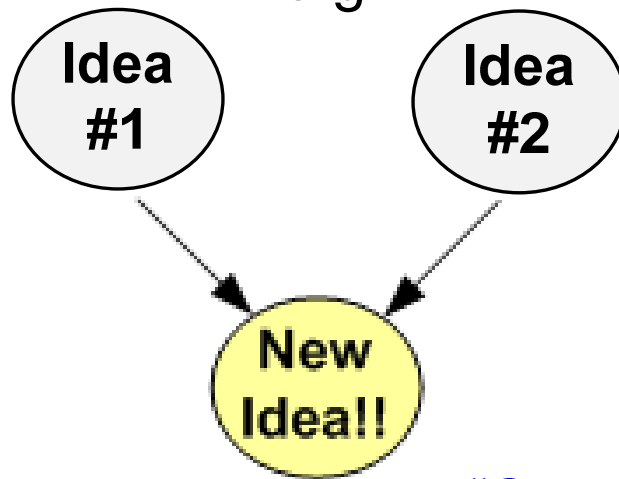
3. Management of Design

- To Manage Design → “Planning” is needed!
- Why Plan?
 - Clear Framework
 - Agenda for Sequence of Events
 - Priorities of Activities
- Benefits:
 - Focused Goal
 - Helps in Assessing the Gradual Milestones.
 - Overall Progressiveness of the Project.

Design: the intended action of organizing, planning and executing a task to achieve a particular purpose.

4.Creativity of Design

- Creativity: no direct specifications to fully characterize it.
- How to enhance creativity?
 - many approaches are possible
 - e.g.



PDA



Cellphone



Smartphone

“Creativity is just connecting things.”

4.Creativity of Design ...

■ Creative Mind must be:

- Alert and Agile in order to connect the dots.
- Strong Insight of Basic Fundamentals.
- Commonsense!

Goodness of an Idea $\overset{\text{not necessarily}}{\longleftrightarrow \text{X} \longrightarrow}$ Perplexity

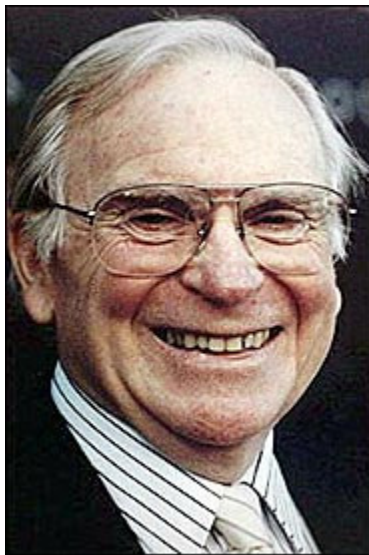


Alamouti Code

S. M. Alamouti, “[A Simple Transmitter Diversity Scheme for Wireless Communications](#),” *IEEE Journal on Selected Areas in Communications*, pp. 1451–1458, Oct. 1998.

4.Creativity of Design ...

- Other Ideas for Improving Creativity?
 - Develop intelligent “**Observation Skills**”
 - e.g. Natural Phenomena:
 - “**bio-inspired system design**”



Robert Kearns



Patent Infringement:
Intermittent Windshield Wiper System



4.Creativity of Design ...

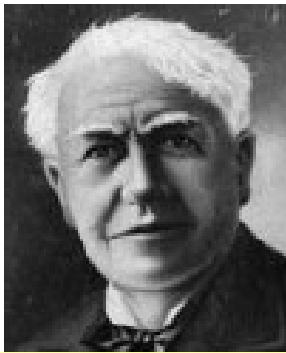
■ Example of Creative Design:

- Kearns used an available System:
 - Original wipers in his 1960s Ford Galaxie.
- He identified an Important Flaw:
 - Wipers continuously move.
- Notices the Sophistication of Nature:
 - Functionality of the eyelids
(blinks every couple of seconds, not continuously!)
- Potential Liaison between Events:
 - Wipers ↔ Eyelids
- Changes the Idea into a System:
 - Builds the circuitry for the improved wiper system.



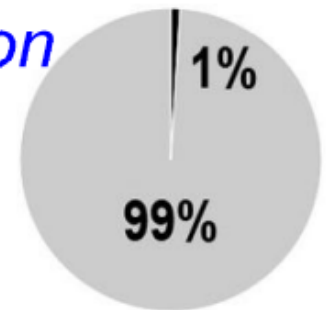
5. Execution of Design

- For Good Design → an “**idea**” is needed.
- However, “**execution**” of an idea is as important or more so than the idea itself!!!



Thomas Edison

*“Genius is one percent inspiration
and ninety-nine percent
perspiration.”*



- “**inspiration**” → initial trigger for innovation
- “**doing**” → building a successful system!

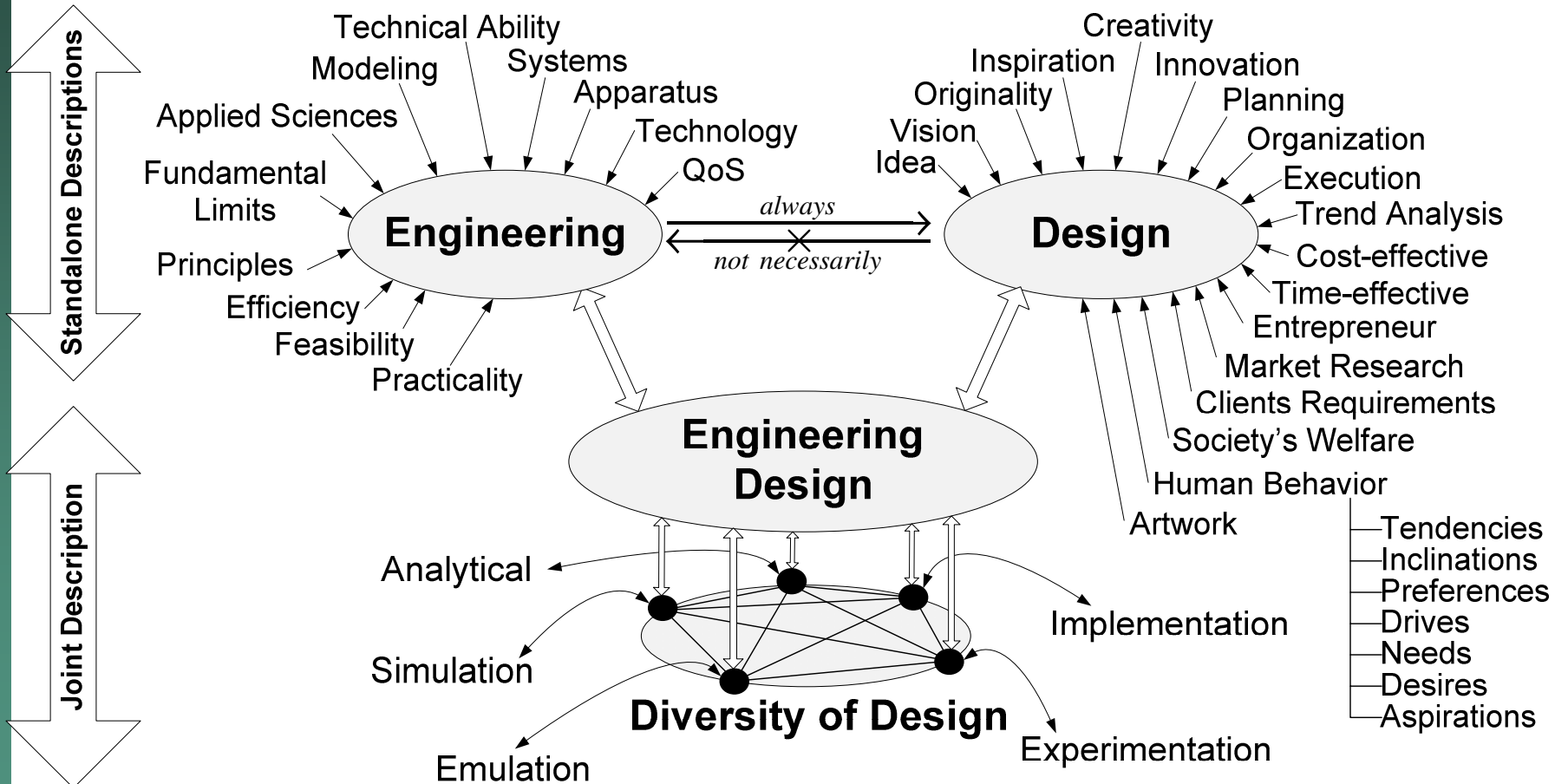
6.Role of Design in Engineering

- What is the relation between “**engineering**” and “**design**”?
- Engineering: focuses on *technical* aspects in making a system operate.
 - Requires: solid foundation of the subject.
 - Talent in manipulating analytical/physical tools.
 - Must be aware of limitations:
 - Fundamental Limits (e.g. Shannon’s Capacity)
 - Practical Restrictions (e.g. system performance, efficiency, feasibility, QoS, ...)
 - Design is needed to “reconcile” these factors.

6.Role of Design in Engineering

- Design: focuses on the ***creative, innovative, artwork*** aspect of the system.
 - In design the outcome is a “***solution***”; not an “***answer***”!
 - Answer – (closed):
 - (near) Idealistic Situations
 - Oversimplified Specifications
 - Well-Behaved, Well-Defined
 - Deterministic System
 - Solution – (open-ended):
 - Realistic Engineering
 - Accurate Analysis
 - Tradeoffs; Cost/Benefit Analysis

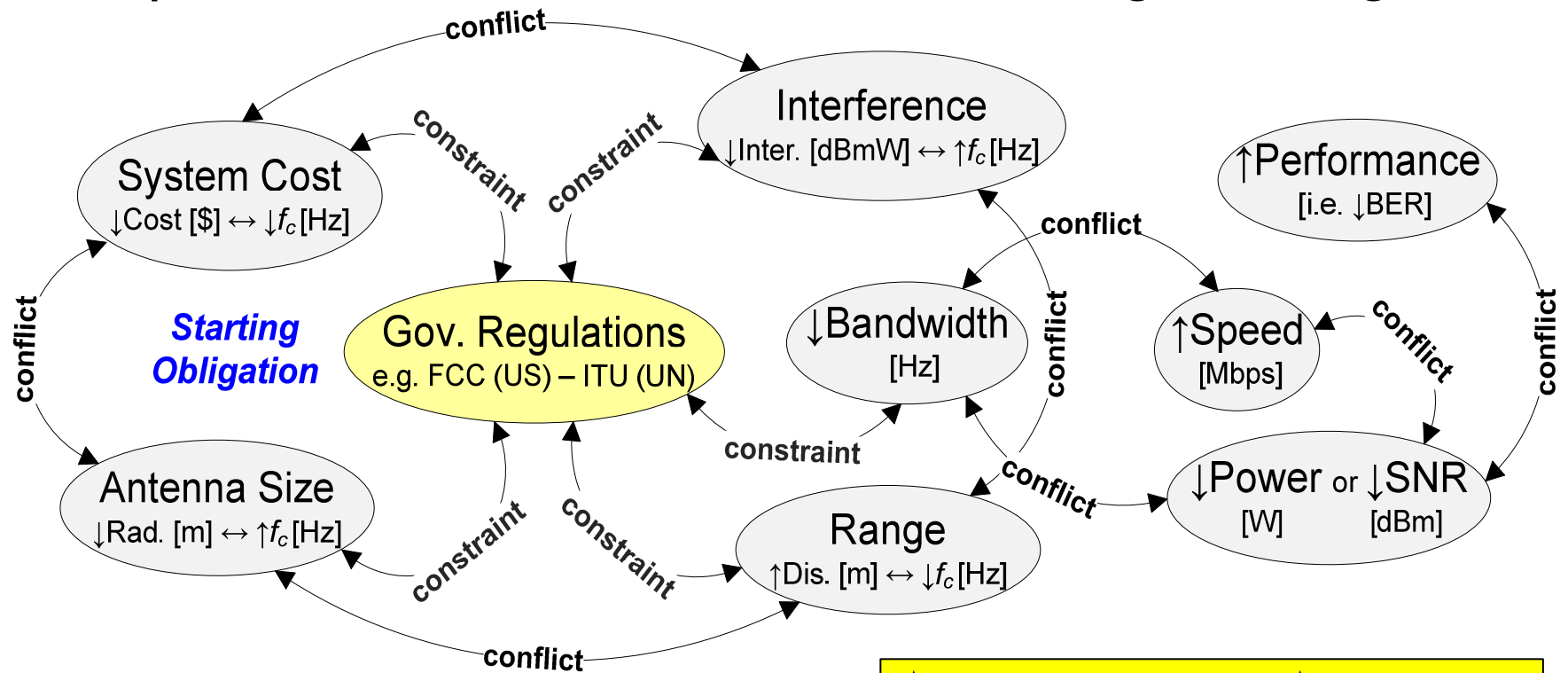
6.Role of Design in Engineering



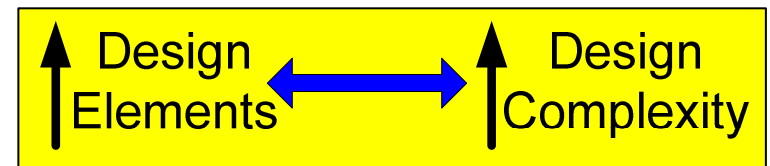
Simple Description of ED ☺

7. Entanglement of Design

■ Optimization Problem: Wireless Engineering



Various Interdependencies will result:
1) Constraints
2) Competing Requirements



8. Diversity of Design

- How to Design a sophisticated system?

Using “**Hands-on**” 😊

- What do we suggest by “**hands-on**”?

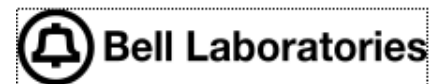
- Physical Experimentation (i.e. HW)
- Other Design Approaches? Simulations

- Cost-effective
- Enable simple parameter modifications
- Fast Computation



Hermann Haus

Lab-based experimentation is one of his “**philosophy of life**”



Richard Hamming

Predicted/
Demonstrated that
90% of experiments
would be conducted
on computers

Paradox?

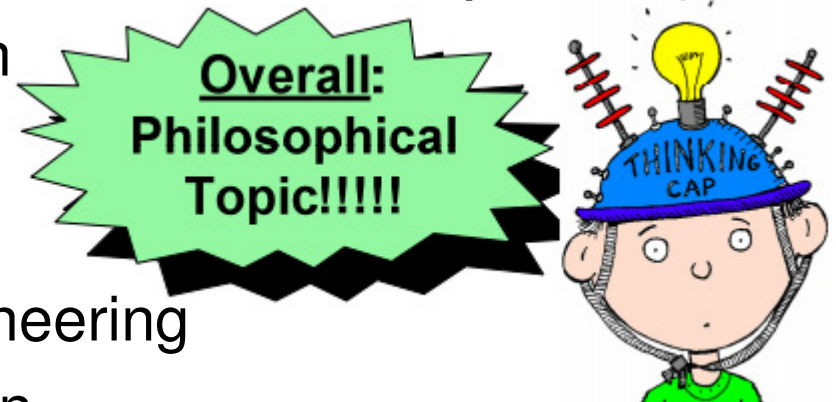
8.Diversity of Design ...

- Stretch the typical understanding of design to multiple domains:
 - Analytical: predictable models
 - Simulation: computational techniques
 - Emulation: map physical phenomena via HW modeling
 - Experimentation: physical reality

**Comprehensive
Design!!!!**

9. Conclusion

- Attempted to articulate a simple interpretation for the notion of **ED**.
- Disaggregated the topic into various spheres.
 - Management of Design
 - Creativity of Design
 - Execution of Design
 - Role of Design in Engineering
 - Entanglement of Design.
- Also, commented on the idea of design diversity in order to produce “**great design**” a.o.t. “**good design**”.



9. Conclusion

- More details in the Paper!
- Available Online: <http://arxiv.org/abs/1305.4148>
<http://library.queensu.ca/ojs/index.php/PCEEA/article/view/4823/4770>



<https://ceea.ca>



Any Questions!

“Judge a man by his questions rather than his answers.”



– Voltaire

THANK YOU!! 😊

