Universal laws and architectures: Theory and lessons from

brains, bugs, nets, grids, planes, docs, fire, bodies, fashion, earthquakes, turbulence, music, buildings, cities, art, running, throwing, Synesthesia, spacecraft, statistical mechanics

John Doyle 道陽 Jean-Lou Chameau Professor Control and Dynamical Systems, EE, & BioE

A minimal prologue

Diverse applications

Aerospace **Robotics** Biology Fluids **Physics** Medicine Internet Smartgrid Ecology Neuroscience

Tuesday

Wednesday

Thursday

Monday

Diverse applications



Details are not serious

Diverse applications (not just engineering)

Aerospace **Robotics** Biology Fluids **Physics Medicine** Internet Smartgrid Ecology Neuroscience



Diverse mathematics (not just "applied")

ODE/PDE Automata Analysis Optimization Prob&Stats Operator Th Diff Geom Alg Geom Cmp Cplxty

Diverse applications

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Diverse mathematics

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CDS as architecture

- Architecture= "constraints that deconstrain"
 - -Constraint = CDS core concepts and math
 - –Deconstraint = connections between new applications and (also possibly new) math
- How to explain this?
- Laws: Universal constraints on achievable robust performance and efficiency
- Architectures: Universal organizational strategies to flexibly achieve what is possible
- Case studies: concrete and familiar examples to illustrate "universals"

Core protocols

- •From Architecture slides, understanding the "OS" is difficult and essential
- •But term "OS" seems to confuse
- •Replace with "core protocols"?
- Highly conserved/constrained core (knot)
- Highly diverse/deconstrained edges
- •What is "CDS" in this context?



Tradeoffs



Tradeoffs = "laws?"





Architecture = Constraints that deconstrain







Horizontal versus vertical is an arbitrary convention.

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"Pasteur's quadrant?" (Donald Stokes)

Quest for fundamental understanding

Basic	Use-inspired
research	basic research
(Niels Bohr)	(Louis Pasteur)
	Applied research (Thomas Edison)

Consideration for use

Typically poor choice of colors and font sizes



"Pasteur's quadrant?" Redrawn

























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Caveats

- Many ideas are classic "robust control", but much of the organization (the architecture) is fairly new
- Motivating case studies also new
 - •
- Many rough edges
- Nobody is working on it quite like this
- •We want to change that