C L Magee Biases

- Based upon **Practice** Experience
  - ***Legacy*** is more important than one usually realizes in the design of real systems
  - ***Standards and protocol design*** is the major way to influence the "design" of real world complex systems
- Based upon **Materials Science** Education and Research Experience
  - Physics as "model" discipline
    - Observations of reality are the gold standard
    - Mathematical models are essential for real progress
  - Materials Science Mantra as a Metaphor for what we are trying to do in Systems Architecture

More on CLM Biases

- Physicists (and copiers) Biases
  - The key to any Scientific Advance is to “explain the complex visible by some simple invisible” Jean Perrin
  - “Unless you can quantitatively measure it, you do not know what you are talking about” Lord Kelvin (Thompson)
  - Caveat (age of earth estimated from Temperature of earth)
- Came to Software/information technology later (1970’s but mostly 1990’s)
- Came to biology later (systematics of interest earlier but mostly 2000’s)
- Strong interest in Economics even in UG education

The Materials Science Mantra

“processing”>”structure”

“structure”>”properties”

A Metaphor for Architecture of Engineering Systems ?

THE METAPHOR EXPANDED I

- PROCESSING> STRUCTURE> PROPERTIES
- Structure ~ Architecture
- Where is Design?
- Where is Behavior?
- **Structure** determines/affects **properties**
  - **Structure** is a multi-dimensional term that includes many scales and concepts simultaneously (and thus is not a “simple invisible”)
  - **Properties** include attributes that encompass dynamics, behavior and “ilities”.
  - Relationships between Structure and Properties are plentiful and became strongest as material classes under detailed study increased

THE METAPHOR EXPANDED II

- **Processing** determines **Structure**
  - Different Processing Modes (casting, forging, crystal growth, e- beam deposition, etc.) have different ***control parameters*** (Temperature gradient, stresses, pressure, magnetic and electrical fields, composition, etc.) that affect/determine properties.
  - ***Design*** is thus *modifying the processing modes and control parameters in to obtain the desired combination of properties*. ***Understanding structure is the chief enabler of effective design***
- Engineering Systems Analogies

THE METAPHOR EXPANDED III

- Structure Characterization
  - Materials-Multiple Dimensional and very broadly construed: examples…..
- Engineering Systems Possibilities for Architecture Characterization.. much of the focus of this course in my metaphor

Learnings from Materials Science Experience

- Utility as Scientific framework has been easier to establish than as practice enabler
- Possible Lessons
  - Both Structure and Properties have to be viewed flexibly to make real progress
  - Quantitative Theories relating properties and structure are best evaluated while studying multiple systems
  - Details matter (observation and models)
  - “Concepts” emphasis and meaning changes (e.g., genes)