Paradigms in Physics

Revising the Upper-Division Curriculum

http://www.physics.orst.edu/paradigms

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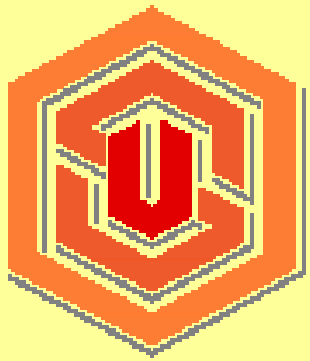

Oregon State University

Support

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- Oregon State University
  - Department of Physics
  - College of Science
  - Academic Affairs
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Collaborative Learning

Constraints

- Diverse Student Interests
  - Industry-bound students
  - Interdisciplinary interests
  - Modern topics needed
- Timing Constraints
  - Coop program
  - Transfer students
  - GRE timing
- Fewer Credit Hours

The Old Curriculum

- Long Sequences
- Traditional Subdisciplines
- Rigid Scheduling
- Choices Difficult
- Junior Level ~ Senior Level
- Can’t Revisit Topic
- Interrelationships Difficult

Changes

- Content
- Scheduling
- Pedagogy
- Hidden Curriculum

What Are Paradigms?

Case studies of paradigmatic physical situations

- Conceptual examples
- Span 2 or more subdisciplines
- Quantum & classical base
- Develop problem-solving skills
- Modern pedagogical strategies

Paradigms

- Symmetries & Idealizations
- Static Vector Fields
- Oscillations
- 1-D Waves
- Spin & Quantum Measurements
- Central Forces
- Energy & Entropy
- Periodic Systems
- Rigid Bodies
- Reference Frames

Integrated Laboratories

What Are Capstones?

- Traditional 1 Quarter Lectures
- Single Deductive Subdisciplines
- Build on Paradigms
- Condensed Format

Capstones

- Classical Mechanics
- Mathematical Methods
- Electomagnetism
- Optics
- Quantum Mechanics
- Thermal and Statistical Physics

Specialty Courses

- Electronics (required)
- Independent research and thesis (required)
- Computational Physics
- Solid State Physics
- Nuclear & Particle Physics
- Atomic, Molecular, & Optical Physics

Flexibility

- Smaller Pieces
- Call Pieces by Name
- Separate Courses
- Longer Blocks of Time
- Intensive Mode

Pedagogy

Encourages both collaborative and independent learning:

- Small group activities
- Integrated laboratories
- Projects
- Learning cycles
- Journal research
- Visualization

Student-Centered Activities

Active Engagement

- Effective but Slow
  - Precious commodity
  - Use wisely
- Special Needs of Upper-Division
- Easily Over-Scheduled
- Can Get Out-of-Synch
- Short Activities Mid-Lecture
- Moving Rooms: awkward but possible

Early Problems

- Too much work for students
- Too much work for faculty
- Different rhythms
- No texts
- Too much collaboration
- Spread of abilities cause ego conflicts
- Some students don’t like small groups/labs
- No exam rehash

Early Successes

- Learning different, but not less
  - Students use more tools
  - Visualization improved
  - Some at risk students blossom
  - Notation problems defused
  - Accessible introduction to thermodynamics
- Everyone benefits
  - Student camaraderie
  - Faculty enthusiasm
  - Benefits TA's
- Three weeks works
  - Cross-disciplines motivating
  - Students like focus
  - Schedule allows short-term focus

Current Focus

- Institutionalization
  - Define what we have done
  - Prepare materials for pass-off
  - Practice pass-off
- Profiles to Demonstrate Success
- Gentle Adoption
- Beta Sites