Summary Report on Curriculum Ideas

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Conclusions Regarding The Chemical Engineering Profession...

- The Chemical Engineering Profession is very successful
  - has moved in many new directions, pushing the understanding and use of new technologies
  - students are highly sought after by industry
  - this has been made possible by the effective teaching of the fundamentals of chemical engineering

… however...

- Chemical Engineering is facing significant pressure from other disciplines

and

- The Current Curriculum is not well integrated:
  - it is compartmentalized in the subjects presented
  - “tired”
- The Current Curriculum is largely ***not***:
  - exploring transformations at the molecular level
  - embracing complexity and uncertainty
    - closed problems with one answer
  - demonstrating the applicability of multiple scales
  - demonstrating/effectively using systems approaches
  - employing relevant, interesting and topical examples to illustrate principles

Integration of the Curriculum: New Core Organizing Principles

- Molecular Scale Transformations
  - chemical & biological
  - physical: phase change, adsorption, etc

Old core did not integrate molecular concepts

- Multi-Scale Descriptions
  - from sub-molecular through “super-macro”
  - for physical, chemical and biological processes

Old core covered only macro to continuum, physical and chemical

- Systems Analysis & Synthesis
  - at all scales
  - tools to address dynamics, complexity, uncertainty, external factors

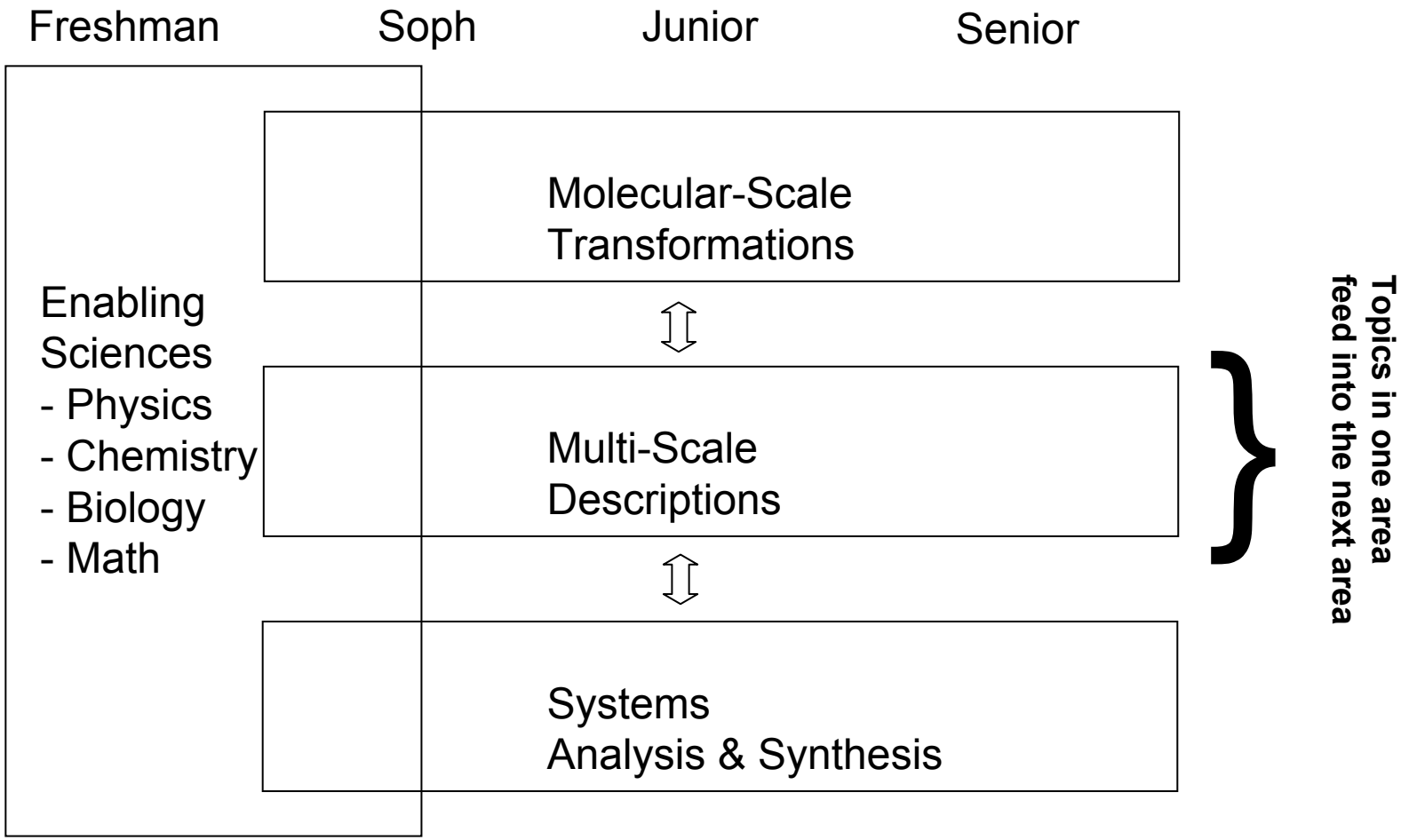
Old core primarily tied to large scale chemical processes

Creation of the New Curriculum: Essential Elements

- Case Studies and Examples
  - Diverse
  - Relevant and Topical
  - Integrated into Curriculum
    - horizontal integration (over time)
    - vertical integration (between classes at same time)
  - Provide real world context
    - safety, economics, ethics, regulation, IP, market/social needs
  - Provide real world challenge
    - open-ended, complex, incomplete data, rapid generation and pruning alternatives

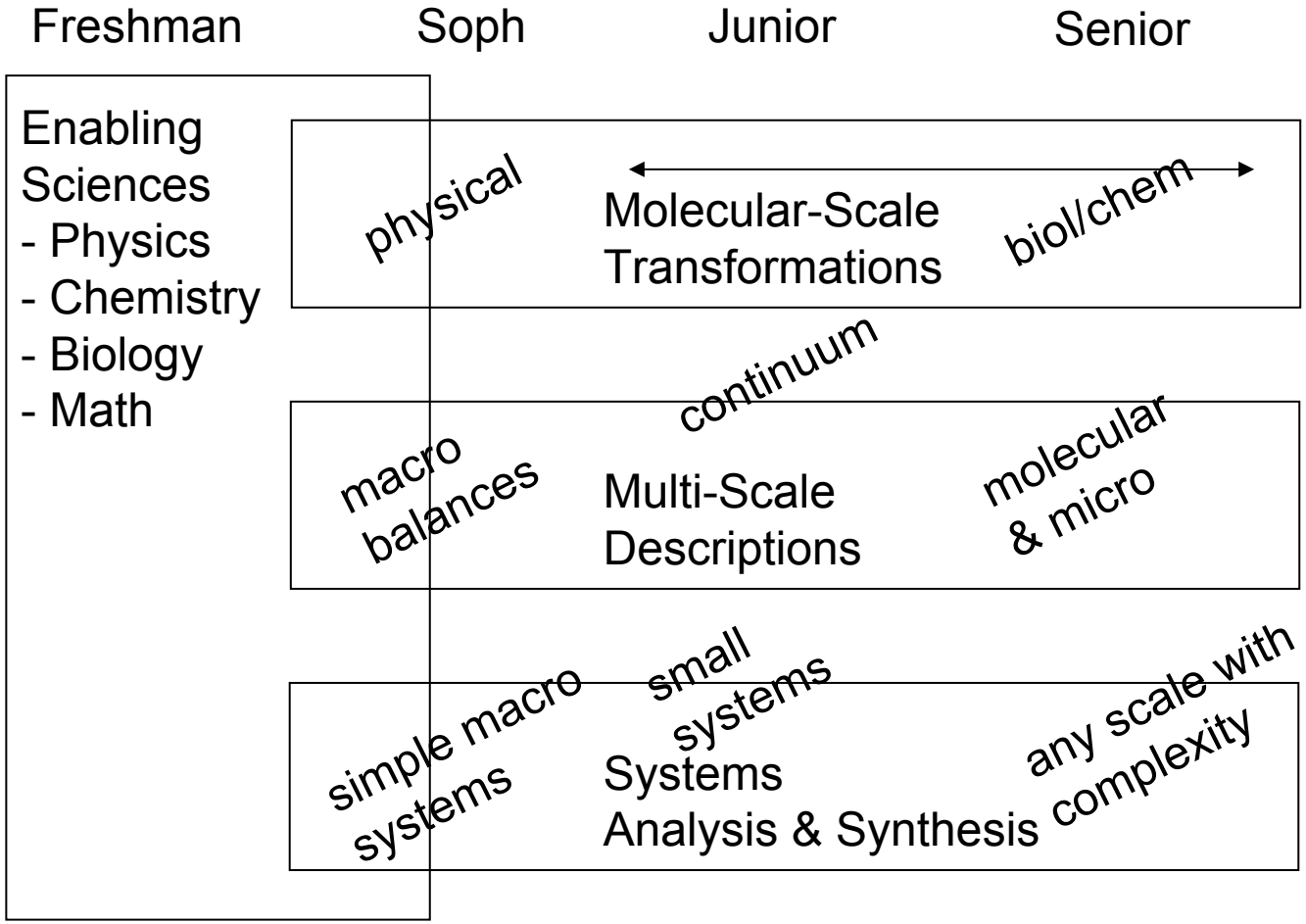
...Essential Elements… (cont.)

- Integrated Curriculum



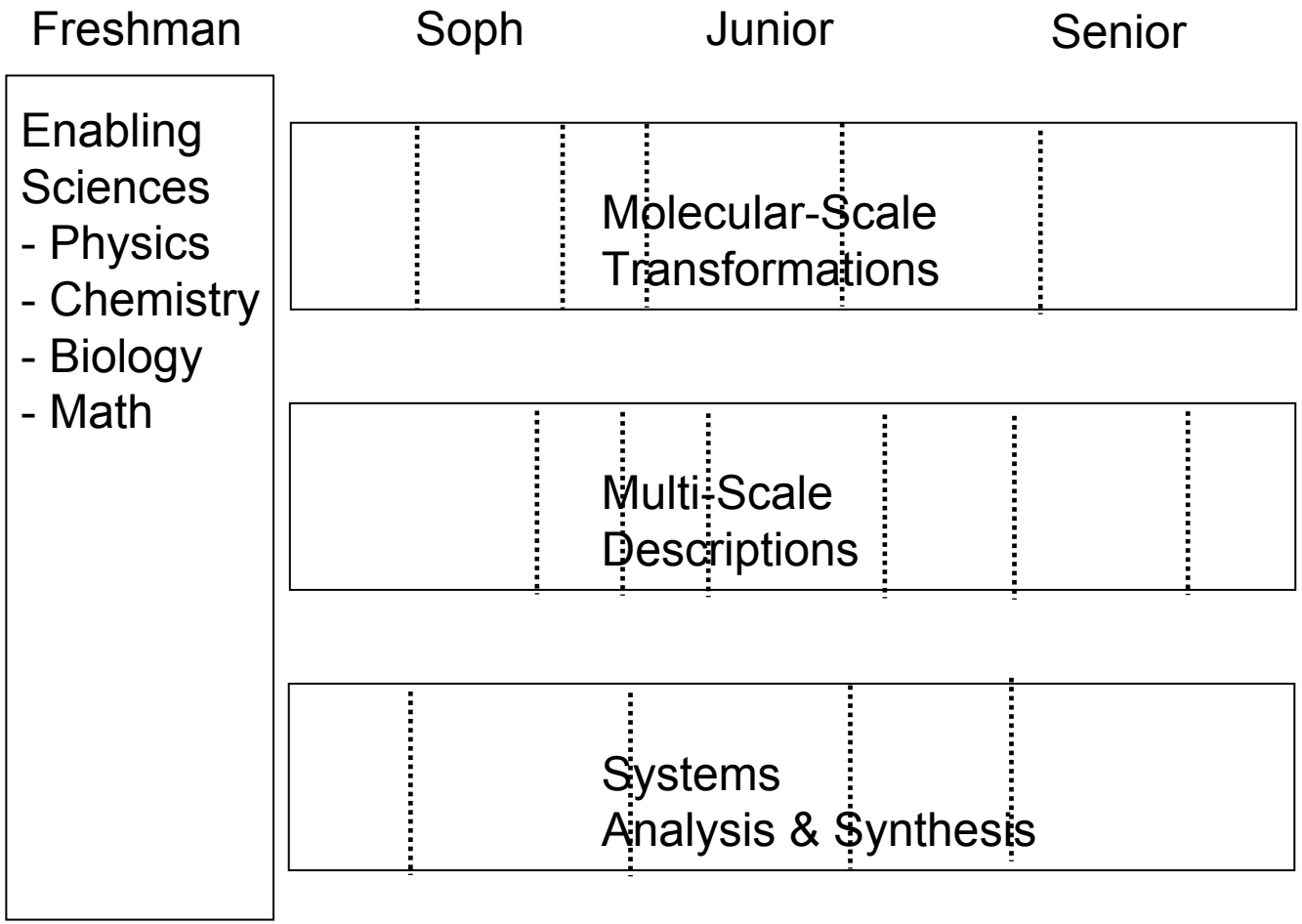
...Essential Elements… (cont.)

- Integrated Curriculum: Incorporating the fundamentals



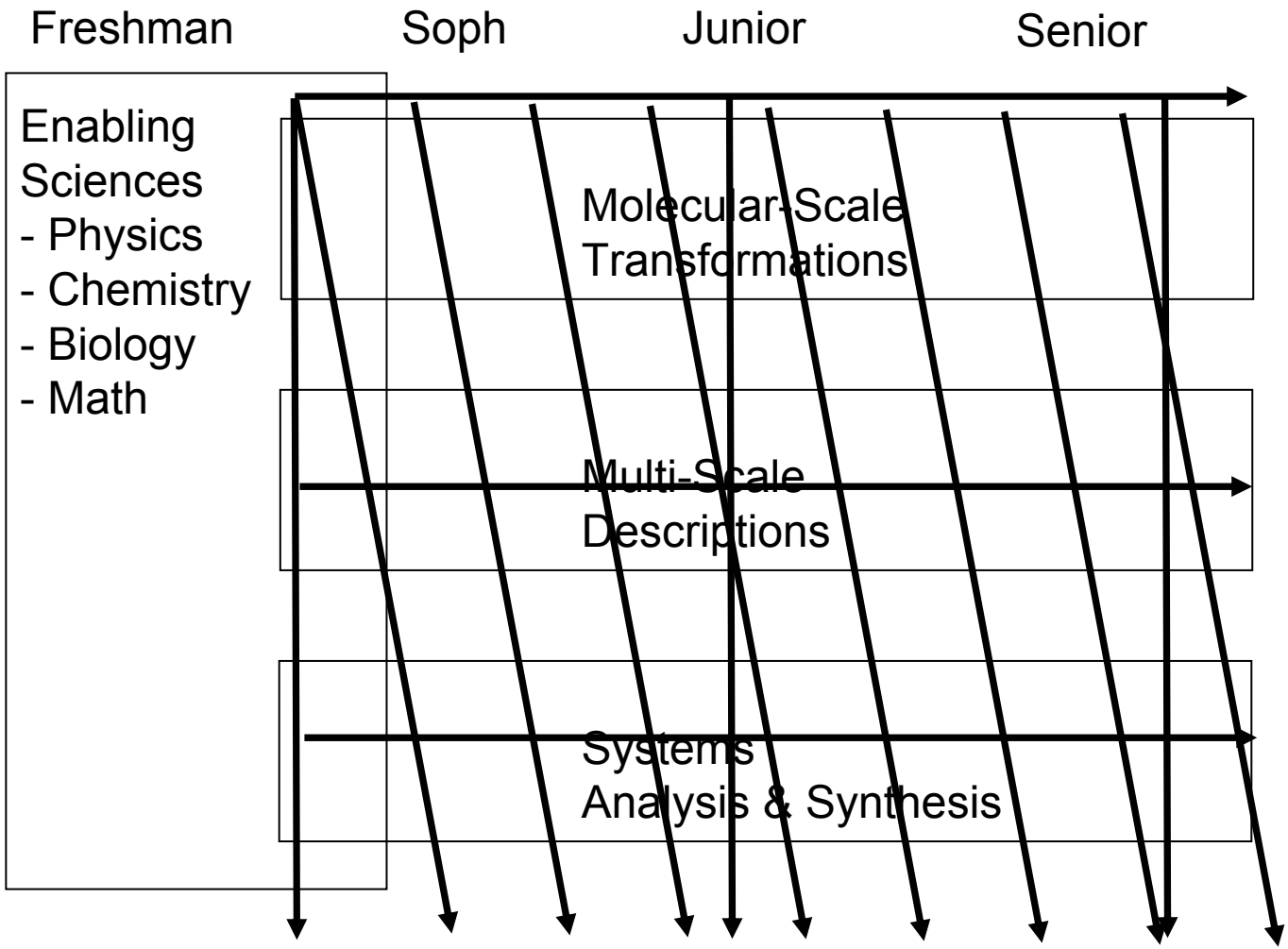
...Essential Elements… (cont.)

- Integrated Curriculum: incorporating modules



...Essential Elements… (cont.)

- Integrated Curriculum: Incorporating Examples



The Spectrum of Curriculum Change: from “tweaks” to “complete overhaul”

- The consensus is that we seek large change
  - the science base has dramatically increased
  - this creates new economic opportunity
  - some discipline will emerge to address these new opportunities
  - chemical engineering is well-positioned to be this new discipline...
  - …but it will require a large change to the undergraduate curriculum
- This change may require a 10 year investment
- We must accommodate a diversity of universities

Discussion following Summary Report – Thursday 2003 April 10

Needs

- Pool of case studies to draw from
- A course must include content, organization, and delivery
  - ChEs qualified to prepare content
  - Need input from others for organization and delivery
- Materials that work at the heart of curriculum
- Remaining effort must depend on this group – not handed off to the professional organizations
- Tap into industrial resources
- What to call old Organizing Principles to make the conversion to the new?
  - Perhaps call the new modules by the old names?
- "Radical surgery" to make core vital, connecting research → core ← new industry
- Ensure graduates KNOW what their core is, in a new delivery scheme

Opportunities

- Web interaction between universities
- Teaching how to learn
  - Isaiah Warner (Chem LSU) et. al
  - This is our opportunity to do so!
  - It must work at the heart of the curriculum
- Outreach to HS students and industry boards
  - CAChE Corp. could be model for distribution
  - Also competitions sponsored by ΩXE
  - Other professional groups, such as the divisions within AIChE
- We can use this to reactivate continual change
- New approach to stimulate invention
- Start new Organizing Principles at grad level as testing ground?
  - This is happening already
- Could we restart the pipeline from research to UG curriculum? (last used ~1970)
- Computations will allow us to make research accessible to UG (bypass advanced math)
- This is opportunity to connect research to UG
- Problems will change, so we focus on strong, versatile skills
- Students must know how to find out information and tools
- Value of our core is that we are able to branch out in many directions
- Core is way of thinking – bio is "just" another application of what we do
- We learn (tools) while we do problems (vehicles)
- ChE is attractive to industry because the ChE core is a foundation for diverse activity
- Integrated modules can also cultivate the attributes, while teaching the skills
  - Teach students how to think about problems
- ChE, with a core, will be able to embrace bio applications

Discussion following Summary Report, continued – Thursday 2003 April 10

Concerns

- If student fails a single module, how to handle in an integrated curriculum?
  - How to handle transfer students?
  - Web interaction may offer new methods for scheduling
- How to test curriculum modules?
  - Find a way to offer, e.g., 1-credit courses in a university
- ABET – how to get on board?
- Are our new Organizing Principle names too abstract/obscure for HS students?
- We (as developers of the curriculum) shouldn't go too deeply into marketing (and thus dilute our effort)
- AIChE can't do engineering education and marketing as a handoff from us
- Connectedness of curriculum could make it difficult for a given university to phase it in.
- Some departments can be radical, some will not
- Different universities presently teach fundamentals at different levels
- "Small scale systems" is still a research problem
- Heavy research funding probably distracts from teaching effort
- The ChE core has served well, but more at earlier times when connected to the active research. Less so recently. It has become a FIXED CORE
- In 60s, faculty covered all fields; in 70s, specialization and increased funding widened field and made it difficult for the individual to cope with it -- in reaction, we left core alone
- Now, research is at the periphery, not the core
- Bring the "research halo" back to center as support for core
- In teaching, bring examples from research (how to explain?) but not necessarily the direct topics/developments of research
- Broader science foundations require more support/interaction with service departments
- How to develop in the ChE faculty the broad foundation (especially bio)?
- Will continued faculty specialization limit us from attaining a core at all?
- This group wants to avoid tracks, to identify/maintain a core
  - Also true at grad level
- Civil engineering as an example of fracturing the discipline
- Volume of information is larger now
  - Will our grads be broad but shallow?
  - Is it a problem?
- Paul Penfield: "ChE is a laughingstock" (for the constraints we impose on our curriculum)
  - Some think ChE is "quaint" for attempting to hold all together
  - We claim wide territory and yet we seek a core; outsiders think we're crazy, that it's unworkable