Session 1: Initial Questions

The workshop opened with an introductory statement by R. C. Armstrong, in which he covered the aims and history of the Frontiers initiative. Workshop participants, divided into four groups, responded to the introductory talk by collecting their questions about the curriculum initiative. A summary of these appears first, followed by a transcription of each group's questions.

Summary

The Frontiers curriculum is grounded on three Organizing Principles: understanding of molecular scale processes, analysis over multiple scales, and the analysis and synthesis of systems. Participants reflected on the topical content of a curriculum:

- inclusion of particular topics, such as sustainability, ecology, energy, risk, uncertainty
- the laboratory requirement
- science teaching and liberal education
- present features that are to be removed

Participants also inquired about the larger aims and methods of a curriculum:

- balance between rigorous detail and big-picture overview
- merits of creating ChE subdisciplines
- reliance on project-based instruction modules
- preparation for the Professional Engineering examination
- how to build professional skills into the foundation of the technical content

There were many questions about the logistics of a new curriculum:

- when, how, who of development
- when, how, who of deployment
- resources available and to be developed
- resistance to change
- method of assessment
- possible change in existing university culture and practices

Finally, there were questions about parties besides the universities

- industry
- ABET

Group 1 Questions

- When will this happen? (deadline?)
- What gets eliminated from curriculum?
- How much biology, etc.?
- Who is going to write the books? Volunteers?
- How will this Frontiers activity evolve to form the next BSL? Will it "trickle down" to all departments?
- Product design – how to teach?
- How to design an undergraduate course on sustainable engineering, industrial ecology, etc. for the sophomore or junior? How to incorporate the molecular, multiscale, and systems principles into this course?

- What will ABET say?
- How to make a curriculum rigorous, while covering a "big picture" systems view?
- Where does the integrative, systems, design element come in?
- Suggested topics in the curriculum:
    - History & technology of coal/coke/coal gasification as a module; analyze the technology involvement
    - Utilize biomass
    - Solar energy
- How much lab work is necessary? Any? How about a web based "game"? Nonlinear data investigation?
- How are we integrating critical thinking into all this? Oral communication? Teamwork?
- How do we assess these?

Group 2 Questions

- Include particulate multiphase systems?
    - i.e., more varied/updated "content" as well as focus on "attributes"?
- How to influence/renovate teaching of the sciences? [biology, chemistry., physics] + math? (e.g. statistics displacing calculus?)
- Include uncertainty ↔ safety thinking + skills?
    - various types of risk: financial, environmental, safety
    - Safety → at molecular, macro, + process scales
- "What if" risk analysis scenarios, e.g. start-up.
- Effect of new curriculum on academic standard operating procedures:
    - e.g. hiring, evaluation, faculty culture, reward/incentive for curriculum development
- Still has to be 4-yr program?
- Need partners to help expand beyond faculty expertise
    - Training material + resources for faculty
    - e.g. six-sigma (argh!) wanted by industry

Group 3 Questions

- Form of instructor support?
- What is a module?
- How do you get started on a new curriculum? Phase-in transition?
- How do you get buy-in?
- Faculty resistance to change? Individual or group?
- What about biology?
- How do we build flexibility? Should we create distinct disciplines within ChE?
- Breadth of ChE – do we have an identity problem?
- Show applications to students early on.
- How do you ensure coverage of key concepts?

Group 4 Questions

- Industry wants professional. skills; the Frontiers initiative talks about academic content. How are these to be integrated?

- Make curriculum more interdisciplinary, also with other engineering disciplines, etc.
- Where to fit sustainable development?
- How will we re-educate the professors?
- What will faculty look like in 20 years?
- Is curriculum restricted to 4 years?
- How to have "project-based" courses that include intentional consideration of "other" issues (e.g. social impacts, sustainability, etc.)
- Do we qualify students to get a P.E.? Should we? (vs. producing an applied scientist, e.g.)
- What do we drop to make room? (transport phenomena?)
- Where does the non-technical (liberal) education fit? How much?
- How to incorporate biology when it is such a lab-intensive field?
- How do we free up time for faculty to engage in curriculum change?
- How do we reward faculty?
- How to overcome resistance of (tenured) faculty?