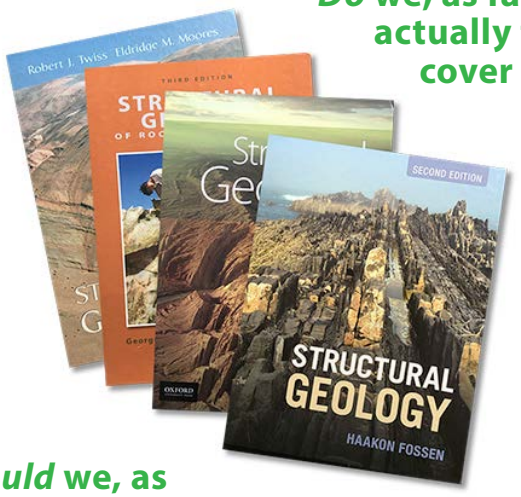
ON-RAMPS
to more effective teaching in tectonics

Re-thinking coverage & linearity

Should courses be driven by the content of comprehensive textbooks? What alternatives are there?

Do we, as faculty, actually try to cover it all?



Should we, as faculty, try to cover it all?

- **Just because you have covered something doesn't mean that your students have learned it.**
- Students learn when they are actively engaged in building knowledge and when they apply what they know to solving problems, particularly relevant ones.
- Courses that give students effective practice plus opportunities to apply what they have learned cannot cover everything in a modern textbook.

What do faculty surveys tell us?

- At the NSF-funded workshop on Teaching Structural Geology in the 21st Century in 2004, 70 faculty who teach undergraduate structural geology filled out a survey containing a list of 80 topics covered in a typical structural geology textbook.
  - Only 15 topics were considered crucial by more than 75% of respondents.
  - Only about half of the 80 topics were considered "crucial, a must" by more than half of the respondents. The other half of respondents either do not teach these very same topics at all or would consider shortening or eliminating them.
  - ~15 topics were not covered at all by more than half of the respondents but were listed as crucial by 7-20% of respondents, depending on the topic.
- **Faculty do not, in fact, try to cover the full range of topics.** Because we truly *can't* teach it all, we each make different decisions about what to omit, but our students still succeed in graduate school and in the work world.
- **There is truly no one right list of topics.** Faculty make different decisions for sound reasons. Surveys in other geo subdisciplines (*e.g.*, hydrogeology) paint a similar picture.

Take-home messages about coverage and course design

- **The faculty survey results are very liberating. Because there truly is no one right list of topics, it gives us the freedom to move beyond the tyranny and illusions of coverage in a course.**
- Textbooks are comprehensive and give a misleading impression of topics that faculty actually cover. We should not feel compelled to cover it all – no one does (at least not effectively in terms of student learning!).
- Using a "less is more" approach (covering fewer topics but doing each more deeply), combined with involving students actively in analysis and application, results in more effective learning than an approach focused on exposure of students to topics covered by the instructor.
- There is no "right way". Courses should be designed around what *your* students need and what you want *your* students to be able to ***do*** as a result of having taken your course.

A typical linear approach

- Courses are commonly arranged around a linear sequence of topics in a discipline, much as textbooks are. Theory, concepts, and skills typically come first, with application coming toward the end of a course in a culminating final project.

Why consider a non-linear approach?

- A non-linear approach frames a course around a series of real-world problems, scenarios, or case examples, rather than around topics in a discipline.
- Students learn about a particular topic to answer a specific question. Scenarios typically revisit topics with increasing depth as the course progresses.
- Scenarios illustrate the broader context of discipline-specific topics and skills, demonstrating links to other relevant disciplines.

See examples on page 2!

The On-Ramps Project provides quick-start guides for faculty interested in incorporating successful and easily implemented teaching strategies to improve student learning in the broad field of tectonics. The Project was funded by NSF grant EAR1841227 and grew out of a recommendation in the 2018 community vision document Challenges and Opportunities for Research in Tectonics.

Example 1: Structural Analysis of Rocks and Regions – University of Edinburgh

- This course is framed around a set of case examples from deformed regions around the world that, combined, illustrate all important deformation processes, deformation environments, and tectonic styles.
- Case examples are not simply presented to students. Students build their experience with key concepts and skills in structural geology through analyzing multi-scale data sets from the regions in the case examples.
- Cases include the Helvetic Nappe Stack, where students use classical field studies to explore, *e.g.*, strain analysis, kinematic indicators and deformation mechanisms.
- The course emphasizes the link between plate motions and rock response along plate boundaries and leads students to the frontiers of research in tectonics and structural geology.
- Download details plus the syllabus.

Example 2: Structural Geology – Wesleyan University

- In this course, structural geology concepts are taught in the context of a variety of applications of structural geology to topics of societal interest: volcanic hazards, earthquake hazards, mountain building, planetary science.
- The spiral approach of this course, where the core structural geology content is revisited, adds depth to students' analytical abilities and enables students to do increasingly sophisticated analyses of the case examples as the course progresses.
- Few students in this course will go on to become structural geologists. The emphasis of this course on how the concepts and skills of structural geology are applied in other disciplines increases the relevance.
- Download details plus the syllabus.

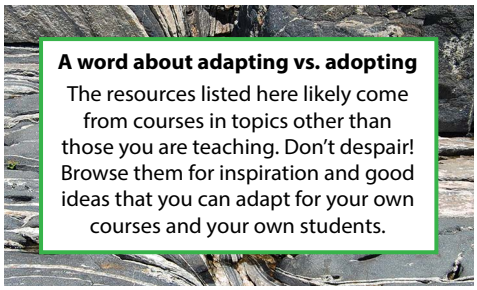
Example 3: Structural Geology & Tectonics – Hamilton College

- Geologic history and processes in Cascadia are threaded throughout the geo curriculum at Hamilton, and students analyze aspects of Cascadia in multiple courses using different data sets. Cascadia was chosen because geologic processes and societal issues are strongly linked.
- Structural Geology & Tectonics is framed around the overarching question, "What is the earthquake risk in the Seattle/Puget Lowlands area of Cascadia, and why?"
- Students build experience with the concepts, analytical methods, and relevance of structural geology and tectonics using real-world data sets to investigate questions that must be answered to evaluate the risk. For example, what deformation mechanisms occur along the subduction interface? How and why do they change with depth, and how does this affect earthquake risk?
- Download details plus the syllabus.

Resources for course design and re-design

From the NAGT portal *Teach the Earth*

- *On the Cutting Edge* has a terrific self-paced course design tutorial that provides a practical pathway to designing effective and innovative courses such as those described above.
- *Teach the Earth* has a database of courses – enter the course topic into the search box; choose Course Descriptions/Syllabi.
- *Pedagogy in Action* has modules on effective teaching strategies for actively involving students.
- Major research frontiers, grand challenges, and thorny problems in structural geology, geophysics and tectonics



A word about adapting vs. adopting

The resources listed here likely come from courses in topics other than those you are teaching. Don't despair! Browse them for inspiration and good ideas that you can adapt for your own courses and your own students.

Paper on designing effective and innovative courses

Tewksbury, B.J. and Macdonald, R.H., 2007, A practical strategy for designing effective and innovative courses, *in*, Karukstis, K.K. and Elgren, T., eds., Designing, Implementing, and Sustaining a Research-Supportive Undergraduate Curriculum: A Compendium of Successful Curricular Practices from Faculty and Institutions Engaged in Undergraduate Research: Washington, DC, Council on Undergraduate Research, p. 127-136.

More On-Ramp pdfs & resources: serc.carleton.edu/onramps/index.html

- What are On-Ramps?
- Interactive lectures
- Brainstorming
- Concept sketches
- Jigsaws
- Compelling discussions
- Quantitative skill-building
- A just-in-time approach
- Case studies
- Re-thinking coverage & linearity
- Gallery Walk
- Flipping the classroom
- Designing effective courses

Re-thinking coverage and linearity On-Ramp authors: Barbara Tewksbury and Florian Fusseis.
On-Ramp Project leads: Phillip Resor, Barbara Tewksbury, Jennifer Wenner. **Additional authors:** Kim Blisniuk, Cailey Condit, Anne Egger, Kyle Fredrick, Jamie Kirkpatrick, Sara Mana, Beth Pratt-Sitaula, Christine Regalla, Carolyn Tewksbury-Christle. **Graphics:** Logo - C. Tewksbury-Christle; photos - banner & p. 2, C. Gerbi; p. 1, D. Tewksbury.