

CONCLUSION

We hope that this exploration of Information-Rich Engineering Design has sparked ideas that you will incorporate in your design classes to enable your students to make more effective use of a diverse range of information resources in their projects.

An informed approach to engineering design starts with laying a firm foundation, setting expectations for information gathering, and having teams develop codes of conduct for participating in information gathering and sharing resources among team members. Embedding the need for good information habits in the context of the ethical responsibilities of engineers, one of which is to provide accurate advice to clients, will impress upon students the need to take an informed approach seriously.

In the problem definition stage of the design process, students who uncover vital information well beyond that given to them by the client will produce more robust solutions—solutions more responsive to their clients' real needs. If students are guided to take the time to consider the solution context, environment,

and culture they are designing for, and if their solutions meet professionally recognized external standards of performance, then they are becoming good engineering designers.

When synthesizing solutions, students who harness the substantial amount of prior art—knowledge of stuff that already exists—rather than attempting to reinvent it themselves, will save time, reduce costs, and come up with more sophisticated solutions with superior performance. By utilizing the information they've gathered within an evaluative structure, students will rapidly converge on the most promising solutions, thereby not wasting precious course time following false leads. By systematically analyzing materials and components, students similarly will efficiently locate the best materials for the job, rather than making do with suboptimal materials that may not be suited for the environment in which their design solution will be used.

Finally, students who manage their information effectively and efficiently will be able to draw upon it in the final documentation of

their design project, providing just the information needed to make a persuasive, complete argument for their particular solution over other choices. And, once the project solution has been communicated, informed learners will reflect on their experiences in order to improve their professional practice, so they won't have to reinvent their own wheels in subsequent work.

In terms of implementing an information-rich approach to engineering design, we offer two practical pieces of advice. First, it is often easiest to implement information activities gradually over time. It is best to focus on one stage of the design process and to try implementing one of the activities or exercises suggested in this handbook, see what happens, improve, and iterate. Completely overhauling a course can be a way to make a clean break with past activities, but if the instructors and students are trying to master a new approach at the same time, the results can be disorienting and frustrating for both, and the new approach abandoned without being given a full test.

Second, if you value the information activities, make sure the course grades reflect that emphasis. Students are typically strategic learners. If they see that the bibliography of their reports is only worth five points, they will devote five points' worth of effort to gathering information. Providing positive reinforcement throughout the course that information is important and expecting them to gather information at different stages of their design process, on the other hand, will help students internalize that ethos, and the practice will make it easier to locate information in their future activities.

This process works best when engineering educators and librarians work together as a team. Librarians will be aware of the latest information tools and resources, best practices in information organization, and how to extract relevant and appropriate information from

technical sources. Engineering educators understand the design process and will have an intuitive feel for the challenges students face and the pedagogies that resonate with them. They will be more familiar with the content of technical information and can share how they use information in their own practice. Integrating the synergistic strengths of these two professionals can transform the ways engineering design is taught and how information literacy is acquired by students.

If you are an engineering educator, we recommend that you find your institution's librarian and see how you can work together to make students aware of all the resources available to them, and guide them in how to locate, evaluate, and apply that information to their design projects. Higher quality projects are much less onerous to grade, so time invested in teaching information skills to students will reap rewards at the end of the course. If you are a member of the American Society for Engineering Education (ASEE), check out the activities of the Engineering Librarians Division at the annual conference.

If you are a librarian, track down the engineering design instructors at your institution and ask them about their course and what challenges seem most difficult for students, and see if any of them resonate with some of the ideas discussed in this handbook. If so, you can suggest that they try some activities to help students meet those challenges. Small successes can lead to more substantial collaborations, and eventually, perhaps, to a full-blown information-rich design process. Remember that design activities may be taking place across the engineering curriculum, from a first-year introduction course to a capstone design experience. Some engineering programs are experimenting with incorporating a "design spine" where the students have a structured design experience each year, if not

each semester. Students are afforded the chance to build increasingly sophisticated information skills if they are embedded sequentially across the curriculum in a purposeful manner.

Our hope is that sharing this handbook with your counterpart at your institution will lead you to productive discussions and potential

collaborations to help your students learn professional skills in an authentic design context. Ultimately, we believe that taking an information-rich approach to engineering design will lead to students better able to function and stay abreast of innovations in our fast-moving modern engineering profession.

