



# Factor Ten Engineering (10xE)

Very few power and industrial plants, commercial and residential buildings, vehicles and transportation systems are as energy and resource efficient as they could be. That is partly because many designers are not aware of the kind of efficiency levels that are achievable, while even fewer know how to realize radical efficiency in their designs. Indeed, engineers, architects, and other design professionals are rarely trained to achieve breakthrough efficiencies in a way that can reduce capital and operating costs. ***If the world is to meet the daunting energy, resources, prosperity, environment, development, and security challenges that we face, the dominant design approach must change.***

With this in mind, RMI's Factor Ten Engineering (10xE) project aims to revolutionize how engineering is taught and practiced. Engineering programs teach designers to optimize isolated components for single benefits. Factor Ten Engineering will show engineers that optimizing an entire system can achieve much greater energy and resource efficiency. Key to this revolution is the creation of a compelling casebook for use by engineering students, teachers, and practitioners worldwide.

## 10xE Approach

Spreading the integrative whole-system design principles throughout academia and industry is our ultimate goal with 10xE. Having created and implemented whole-system engineering with clients in 29 sectors over the past 27 years, RMI will select a mixture of internal and external cases that combine dramatic savings in energy and other resources with a design approach that typically achieves those savings at comparable or lower capital cost.

### **Integrative design faces four main barriers:**

- i. Lack of Methodology: There is no widely known, generally accepted engineering approach to whole-system design. Currently, engineering disciplines are specialized and engineering education is fragmented.
- ii. Lack of Training: Very few academic or industry training programs stress the importance of treating the disparate pieces of an engineering project as a singular interconnected system.
- iii. Lack of Implementation: Designers who know how to do whole-system design are often stymied by a focus on capital cost, not lifecycle cost, and the assumption that efficient designs cost more to build.
- iv. Lack of Results: Without an accepted methodology, a lack of incentives and compelling results to showcase and benchmark the benefits of whole-system design, inefficient engineering is implemented over and over, reinforcing the status quo.

### **10xE attacks these obstacles through a multi-step process:**

- i. Create case studies comparing traditional and 10xE approaches side by side in easily understood, vivid examples.
- ii. Consult stakeholders to ensure that we address the needs, opportunities, and obstacles throughout the engineering value chain.
- iii. Organize an intensive, transdisciplinary "Summer Study" where the best teachers and practitioners of whole-system design will select, refine, sequence, and connect the best several dozen case-studies into a widely usable casebook for testing and broad dissemination.

## Storytelling through a casebook

Humans are hard-wired for storytelling and case studies are a powerful device for shifting human thinking. This is why the main 10xE tool will be a casebook comparing traditional engineering approach to radically efficient one. Along with the casebook, we are organizing a preliminary virtual "Spring Study" in April 2009—a series of interviews with stakeholders from across the engineering value chain. This feedback will inform our plans to make our subsequent Summer Study as effective as possible. The Summer Study, which is divided into two phases, will bring together the foremost 10xE teachers and practitioners. The first phase of the Summer Study will involve global virtual working groups conducting research to develop

cases and crystallize underlying principles. After the first phase we will edit the preliminary cases through a beta-test with sponsoring firms and educational institutions, and refine and prepare for the second phase of the summer study, which will occur in 2010. The second phase will be a two-week Study to offer feedback on how to assemble the different cases in the right heuristic order with the right connective tissue to tell a coherent story. This will be followed by peer reviews, production and publication. We envision an open-source format, although several business models are under discussion, such as offering sponsoring firms early access and training.

## Creating “Demand Pull”

Publishing a casebook won't change the deeply ingrained ways engineering is now taught and done. We must also create “demand pull”—that is, interest from customers. In essence, corporate decision makers who understand the value of this work be better positioned to align the skill-sets of their employees through training and new hires to enable radical efficiency. The direct economic and social benefits generated by 10xE will create a competitive advantage encouraging other firms to mimic their practices. These benefits, when communicated via industry signals to the academic realm, will force all educational institutions to keep pace with the ones that adopt 10xE early on. The deans we have already engaged in 10xE believe that academia responds quickly to industry needs through evolving curricula. Therefore, utilizing a two-fold approach of effecting change by tackling both the academic and corporate spaces will create a demand pull leading to fast adoption and implementation.

## Budget and Timeline

The total cost of this three-year initiative is estimated at \$2.2 million. This support will be used for RMI research, industry convening, the convening of a Summer Study and creation of an educational casebook, and marketing efforts to drive the changes through industry and academia. In the shorter term, April 2009– June 2010, \$1.1 million is needed to prepare and execute the Summer Study and to produce the beta casebook. While RMI has received seed funding, we seek additional support from a variety of sources—major firms that use or provide design services; philanthropists who support engineering innovation and educational reform at universities; and foundations.

## Needed Support

Why fund 10xE? The benefits are diverse:

- *Competitive Advantage*: Adopting 10xE will help companies save capital cost, lifecycle cost, emissions, complexity, downtime, and often construction time.
- *New Markets*: 10xE will create new markets for efficient design. Entire companies and academic programs will emerge around this new way to create “abundance by design.”
- *Public Image*: 10xE will confer reputational advantage to adopters through its positive impact on climate change and other environmental benefits.
- *Strengthened Employee Development*: Internal 10xE training at sponsors firms will help develop talent and spur creativity.
- *Revolutionary Education*: 10xE aims to shape the next generation of engineers.

## About RMI

Rocky Mountain Institute (RMI) is an independent, entrepreneurial, nonprofit think-and-do tank. It drives the efficient and restorative use of resources to make the world secure, just, prosperous, and life-sustaining.

## Contact

Alok Pradhan  
10xE Project Manager  
+1 970 927 7824  
[apradhan@rmi.org](mailto:apradhan@rmi.org)