Speaking Systems Engineering: Bilingualism in Health Care Delivery Organizations

Legend has it that it was an engineer who invented the job description of a surgical scrub technician—to manage and pass instruments during surgery—after studying wasted motions by filming tonsillectomies for 11 of his 12 children.[1,2] This engineer, Frank Bunker Gilbreth, started his scientific studies of motion as an apprentice in bricklaying. He observed that a bricklayer would stoop 125 times per hour for bricks and 125 times for mortar, and he proceeded to invent a more efficient bricklaying system.[3] Besides founding a new discipline of industrial engineering, Gilbreth's enormous contribution to medicine was frequently recounted.[2] A century later, however, the pursuit of quality and efficiency through industrial engineering methods remains controversial, as evidenced by the reaction to the time-motion studies conducted by a plastic surgeon who achieved astounding results.[4] The challenge remains, as it has been for the past 100 years, how to *routinely* integrate engineering methods into the health care domain.[5,6] In a field in which parochialism often predominates, how do we foster "bilingualism" in the health care delivery system so that concepts and methods from engineering are understood by clinicians and clinical systems are well understood by engineers?

Although fundamental barriers exist for all cross-disciplinary work, they are particularly prominent between disciplines as different as engineering and medicine. Educational systems, academic institutions, and professional bodies enshrine disciplinary distinctions, creating silos with intended and unintended discouragement of cross-disciplinary activities. Literature searches are often conducted only in one's own discipline. Anecdotes abound from federal grant review panels and academic promotion committees about the lack of appreciation, misunderstanding, or even contempt for "other disciplines."

The article by Kamath et al[7] published in this issue of *Mayo Clinic Proceedings* showcases the effort at one leading organization to incorporate engineering into its operations. The Third Annual Mayo Clinic Conference on Systems Engineering and Operations Research in Health Care combined inspirational presentations with case studies. The conference provided a forum for cross-disciplinary discussions. One of the foundational methods in systems engineering (SE) is to provide decision support through modeling, simulation, and forecasting. The conference provided a few examples of exploiting the increasing capabilities in capturing and processing data at various levels to model care delivery. The conference also challenged the simplistic view of translational efforts in deploying engineering methods. Careful consideration of the sociotechnical environment is necessary because of the complexity of the health care delivery system, and ongoing research is needed to identify ways to effectively integrate engineering methods. For example, the conference highlighted the importance of patient-centered care, which is often ignored when efficiency and throughput are the focus of process improvement using engineering methods.

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Nevertheless, as much as such effort should be appreciated, the underlying themes of the conference demonstrate the long road ahead of us. The application of engineering methods to health care is considered to be innovative rather than normal. As long as engineering methods are viewed as an innovation, there will be a need for diffusion. Carayon[8] articulated the steps of diffusion well in an article focused on human factors engineering, and much of the advice in the article applies here. The article outlined 3 types of human factors engineering (HFE) activities at hospitals: using HFE tools and methods, increasing HFE knowledge, and recruiting human factors engineers.

Although it is valuable to have employees who speak both the clinical and engineering languages, bilingualism should not result in the unintended consequence of heightening the silos. We should highlight 2 facets of bilingualism, both at individual and at institutional levels: (1) we need to cross-train the engineering and health care workforce so we understand each other's perspectives and concerns, and (2) we cannot depend on physicians or nurses who have read a book or taken a seminar in SE and operations research to be our SE/operations research experts.

Historically, health care organizations look to their own to take on problem-solving and leadership roles. However, this often results in missed opportunities by involving physicians with some SE knowledge in lieu of true systems engineers who are veritable experts in the field. Health care organizations can start to see the benefits of engineering in health care delivery by incrementally incorporating engineering methods in projects and in educational programs with clinical staff and by bringing nonclinicians with SE expertise into the workforce. Laurie Wolf of Barnes-Jewish Hospital articulated this need well, stating that it is about

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"1% versus 100%": 1% of the workforce as engineers work 100% of the time to conduct process improvement, and 100% of the clinical workforce learns about engineering methods and conducts process improvement 1% of the time (oral communication, 2011). Great opportunities exist for those who are "bilingual" to develop programs and models of education and training for clinicians. To maximize commitment to and application of engineering concepts and methods, learning should be designed as part of ongoing projects. Information sciences and HFE are examples of relevant disciplines.

Similarly, many barriers will have to be overcome to engage more engineers in health care systems. The complexity of health care delivery goes beyond the complexities of the foundational basics such as physiology and clinical sciences. The social, professional, legal, financial, and cultural aspects of health care delivery are often opaque for engineers but are critical in modeling and in successfully engaging with clinicians. For example, an engineer was recently surprised to learn that, within the health care lexicon, the "risk" in risk management usually refers to legal risks to health care organizations rather than the risk to the patient. These kinds of subtleties, although familiar to the clinician, are not well characterized in the engineering literature, and consequently, their importance is often not fully appreciated.

Mayo Clinic represents a growing number of health care organizations taking on health care engineering as an area of innovation. Steady progress has been made by those who are "bilingual" in both engineering and medicine, as reflected by a growing body of peer-reviewed literature. To successfully translate these innovations into routine practices, more efforts are needed, from large organized initiatives to widespread engineering and health care delivery "literacy" campaigns. Health care is delivered in complex sociotechnical systems. Systems engineers understand how to properly analyze these systems, and domain experts such as physicians and nurses understand their subtleties. Health care needs to progress to the point where collaborations between the two are no longer noteworthy and innovative but normal and mundane. The concept of "smart sandboxes," described in the article by Kamath et al,[7] in which engineering academics collaborate with health care practitioners in the health care environment, must gain widespread implementation. Only then will we be able to move to the next level: consistently ultraefficient and ultrasafe health care.

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