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EDITORIAL

Infrastructure: The Price of Inaction

Doing nothing can be a very successful strategy in tiding over difficult situations. Seasoned administrators have often perfected the art of inaction. Sometimes doing nothing can be costly. Fires must be put out and the critically ill rushed to medical care. Even while pondering on the situations in which inaction seemed to be strategically advantageous, my attention was drawn to an editorial in *Science*. The author, Kathy Caldwell, president of the American Society of Civil Engineers (ASCE) titled her column 'The Cost of Doing Nothing' (*Science*, 2011, **334**, 289). She wrote her piece on the eve of an annual gathering of civil engineers, drawing attention to the critical importance of recognizing 'that rebuilding and modernizing infrastructure will be a key driver of economic growth' in the United States, even as the economic crisis continues, largely unabated. The *Science* editorial articulated a civil engineer's call for action.

Civil engineering is an unglamorous field in the world of academia. Yet, few fields impact everyday life in the manner that civil engineering does. The origins of the discipline's name go back to the time when engineering began to influence civilian life, almost as much as it affected military activity. Traditionally, civil engineers have been associated with building activity; townships, dams, bridges, roads and railroads, airports and waterways. Housing, transportation and water, indispensable to daily life depend critically on civil engineers. Indeed the 'infrastructure' for modern life requires the foundational strengths of civil engineering. Technological advances in construction activities have led to the chaotic, unplanned and, at times, frightening growth in our cities as high rise buildings sprout with increasing frequency. Civil engineering is also concerned with hazards; buildings and bridges, dams and nuclear power plants must be insulated from the cataclysmic consequences of earthquakes, floods and even tsunamis, in areas that adjoin the oceans. Efficient transportation is central to a modern economy, with highways and railways being the key elements of connectivity. Depsite its centrality, civil engineering is not the field of choice for most students who aspire to acquire engineering degrees. Most aspirants aim to enter 'computer science' courses, despite its rather curious name which seems to set it apart from the rough and tumble of engineering. Electrical and mechanical engineering courses also seem to win over civil engineering, in the statistics that are published each year after the annual admissions. In India, engineering degrees are often only a device to enter management courses or the information technology industry, whose glamour remains undimmed. Why have I turned to civil engineering, a subject far removed from my own areas of competence or interest? The subject has intrigued me in recent years as I have attempted to grasp the sharp differences that appear to be important between various sub-areas of a vast discipline. These differences can be like fault lines, that appear at the junctions between tectonic plates; largely dormant and silent but often preventing integration of a key subject of study and research. Disciplinary tensions between academics who work in the same broad area of science or engineering are not unusual. Chemistry, an old, traditional subject has always maintained sharp distinctions between organic, inorganic and physical chemists; well drawn and rarely breached boundaries in the Periodic Table. Computational chemistry, a relatively recent field, has served to integrate the sub-disciplines to some extent, creating in the process two new species of chemists; theorists and experimentalists. This is true of physics, too. Curiously, theorists and experimentalists cohabit comfortably; the former constantly on the look out for experimental data, while the latter turn to a theoretical calculation, which always seems to propel papers into print. Biology too has been a fractured field. The classical biologists have for long been trampled over by the frenetic pace of molecular biology. The tide appears to have turned as biology seems to be returning to its roots; the deluge of sequencing and structural information has catalyzed introspection. Do we need more data? Every field of science reaches a turning point. Tensions between subdisciplines are essential to the process of advance. Having digressed, I must return to my original theme; civil engineering and its central role in maintaining our infrastructure.

The *Science* editorial drew attention to the *2009 Report Card for America's Infrastructure* produced by the ASCE. This comprehensive analysis provides grades for 15 categories of infrastructure: aviation, bridges, dams, drinking water, energy, hazardous waste, inland waterways, levees (an embankment that protects crops from flooding), public parks and recreation, rail, roads, schools, solid waste, transit and wastewater. The grading scheme would please teachers; a five-point scale that runs down from excellent (A), good (B), mediocre (C), poor (D) and failing (F). According to the ASCE report, the United States scored 11 D's and 4 C's. Particularly noteworthy

was the fact that drinking water and roads scored low D's (D–). The overall grade point average over the 15 categories was D. The estimated investment according to the ASCE for raising the infrastructure to a 'good condition' over a five-year period would be $2.2 trillion, a number that appears too large to comprehend, for those unaccustomed to global projections (and I am one). What are the parameters on which the grades have been assigned? The ASCE's advisory council considered 'capacity, condition, operations and maintenance, current and future funding, public safety and resilience'. The final grades were determined using 'publicly available data and the subjective judgements of the engineers serving on the council'. Earlier this year the ASCE produced another bleak report on the state of America's 'surface transportation infrastructure … that enable people and goods to access markets, services and inputs of production essential to America's economic vitality'. The analysis suggested that 'the continued deterioration leaves a significant and mounting burden on the US economy' (*Failure to Act: The Economic Impact of Current Investment Trends in Surface Transportation Infrastructure*, ASCE, 2011).

For Indians who have visited America or for the countless others who would like to do so, grim reports of decaying infrastructure are hard to believe. An enviable highway system, that underpins an oil guzzling economy, the absence of power cuts and water shortages is really the enduring image of America in Indian minds. The standards of infrastructure are clearly superior in America. The ASCE report underscores the concern of a community to repair, maintain and enhance the quality of infrastructure. Two issues highlighted in the *2009 Report Card* seemed particularly relevant in the Indian context. The ASCE report notes that 'as dams age and downstream development increases, the number of deficient dams has risen to more than 4000, including 1819 high hazard dams. Over the past six years, for every deficient, high hazard dam repaired, nearly two more were declared deficient'. In India the Mullaperiyar dam is now a bone of contention between neighbouring states. Technical discussion appears to be drowned in the din of political posturing. How many dams need to be evaluated? Is there an independent professional body that can make such assessments? Would concerns arise about the hundreds of bridges, road and rail, that are dotted across the length and breadth of India? Curiously, the area of drinking water secured a low grade, D–, in the ASCE report. After acknowledging that 'Americans still enjoy some of the best tap water in the world', the report notes that 'the costs of treating and delivering that water where it is needed continue to outpace the funds available to sustain the system'. According to ASCE, America's systems are aging, with leaking pipes resulting in an estimated loss of 'seven billion gallons of clean drinking water a day'. The ASCE report articulates very clearly the concerns of a professional body of civil engineers for the apparent decay of, arguably, the best infrastructure available in a large country. A column that appeared a few months ago raised another bogey: 'China vs America: Which is the Developing Country?' (Herbold, R. J., *Wall Street Journal*, July 9, 2011). The column is a paen of praise to the Chinese model of development, with recently built infrastructure in China shining in comparison to America. The author asks: 'Can you imagine the US Congress and President emerging with a unified five-year plan *that they actually achieve* (like China typically does)?' (italics mine). The Chinese 12th five-year plan began in March 2011. India's 12th Plan will, hopefully be launched in April 2012 and it will be instructive to compare investments and commitment to key infrastructure areas.

The word 'infrastructure' is an all encompassing term. The design, construction, maintenance and repair of major public utilities, from power plants to dams, bridges to water treatment plants, railways to airlines, requires a large well trained and experienced workforce. As the level of sophistication increases, the knowledge and skills of the technical personnel required increases. If a report along the lines of the ASCE's America Report Card were to be produced in India, it is likely that we would do very poorly on all counts. One additional parameter that needs to be graded in India is the quality and level of training of the available technical manpower. There appears to be a looming shortage of 'real engineers and technologists', in the most important areas relating to essential infrastructure. If nuclear power turns out to be the only means of addressing power needs, we need to ask if future manpower requirements will be met by the higher education system. Or is the solution that each sector develop an appropriate educational program the alternative? When a crisis develops experts are needed; experts whose judgements inspire public confidence. The current controversies that hinge around safety concerns at Kudankulam or Mullaperiyar appear to need the reassurances of expert groups. In many areas the shortage of 'real experts' is alarming. A report in the press highlighted the problem with an eye catching title: 'SOS: Scarcity of Specialists' (Saxena, S., *Times of India*, 25 September 2011). The report focused on areas where experts are suddenly needed in a crisis. The author argues that '…be it geologists, meteorologists, archaeologists or even vets, we just don't have the experts who matter in a crisis'. As India moves to upgrade infrastructure in a big way, the future requirements for trained manpower to build and maintain utilities need to be addressed. Civil engineers, reinvented as a new interdisciplinary breed, may be among the most needed. This is a problem to be considered and debated even in the cloistered and at times, dangerously comfortable environment of academia. In her commentary, Kathy Caldwell noted that 'although repairing and modernizing the country's infrastructure may seem daunting in lean times, the cost of doing nothing will be exponentially greater'. In India, the consequences of 'doing nothing' will be immeasurably more damaging.

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