Engineering Knowledge Capture and Enhancing Academic Institutional Memory to Support Cyclical Industrial Sectors

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Abstract

Economic activity in different industrial sectors is cyclical. For sectors with long cycle times, downturns in economic activity can result in significant losses of local, national and international engineering capacity as individuals retrain and migrate into other sectors. For engineering sectors faced with demographic challenges, where many world-leading experts are near or past retirement age, this problem can be particularly acute since down cycles eliminate opportunities for mentorship and knowledge transfer between seasoned experts and younger generations of engineers. Such engagement opportunities are particularly crucial in the transfer of tacit knowledge. Traditional approaches for capturing and codifying methods and best practices, such as the development of standards, publishing books and peer-reviewed articles are typically able to capture only certain aspects of the knowledge of a segment of the population of practicing engineers. In the context of economic cycles, academic institutions serve a special function in society as, amongst other things, they help capture and disseminate knowledge and develop skills needed to train future generations of experts and they serve to maintain continuity of a core knowledge base, even during economic down cycles. In doing so, they help accelerate economic recovery in a given sector by ensuring knowledge captured in the "institutional memory" during past periods of high activity are transferred to new, highly qualified personnel during future upturns. This paper discusses ongoing work at Memorial to identify mechanisms for increasing engagement with industry practitioners to better understand what knowledge and skills are crucial to a given sector, and assessing approaches and technologies that can be used to enhance and accelerate knowledge capture from industry practitioners and transfer this to teaching and learning environments in academic institutions which train next generation experts. The highly specialized engineering field of Ice Engineering is explored as an example.

Keywords

Engineering Education. Knowledge Capture. Institutional Memorial. Economic Cycles. Industrial-Academic Partnership.

Introduction

Knowledge is considered to be a strategic resource by many organizations, including academic institutions[1]. In the modern economy, knowledge is often viewed as offering organizations a competitive advantage. Yet during economic downturns, when competitive advantages are perhaps most important, potential exists for significant loss of knowledge and associated technical capacity

as organizations implement cost-cutting measures to contend with new economic realities. Due to internalization and virtualization of education and training resources, as well as market forces, the role of academic institutions are evolving. It is therefore important to evaluate the role of universities in modern economies[2]. While research, innovation and technology development serve as important contributions by academic institutions, universities also play a vital role in the delivery of professional education programs for new engineers and other professions. In this regard, universities play a highly important role in developing and sustaining technical capacity needed to support growth in different economic sectors. In this paper, a discussion is presented of ongoing research undertaken to assess ways that academia can help maintain technical capacity in specialized engineering disciplines to help maintain capacity and support economic recovery in cyclical sectors.

Work in Progress: The Role of Academia in Sustaining Technical Capacity

For sectors prone to long term economic cycles, such as natural resource industries, asymmetries can exist in the demographic distribution of expertise within an organization's team of subject matter experts[3]. In Canada, examples of such asymmetries exist in engineering sub-disciplines, such as Ice Engineering. In such cases, the majority of experts have either 30+ years experience or less than ten years experience. There are very few individuals in the middle range due to past economic cycles that resulted in few new entrants into the field from the late 1980s to the early 2000s. During the period from about 2005 to 2015, a resurgence in demand for such technical expertise has led to many new graduates entering this field, in combination with many senior experts extending their careers beyond retirement age. Current downward trends in economic activity are expected to result in loss of capacity in the technical community. As illustrated in Figure 1 below, this is primarily due to practicing individuals returning to upgrade their education, accepting positions in different sectors, retraining for a different career or retiring.

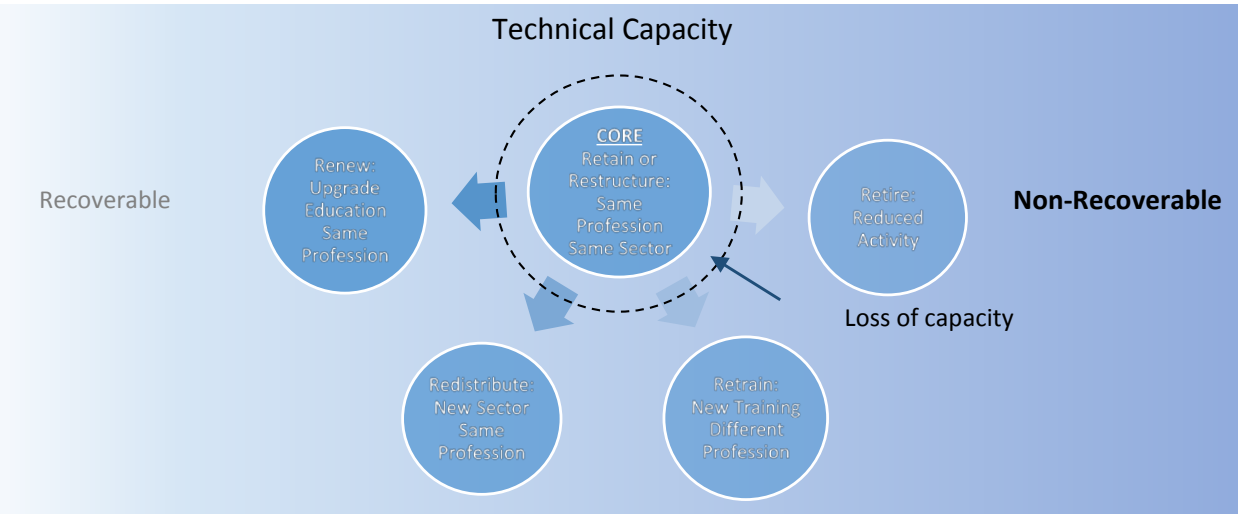

Figure 1: Loss of capacity in technical community during economic downturn (dashed line represents capacity before economic contraction).

The loss of knowledge and expertise associated with individuals who permanently retire or retrain for a different profession may be considered as a non-recoverable capacity loss. Individuals who

upgrade their education within their discipline or continue practicing in their profession in a different sector may be considered as recoverable losses in capacity, since they can potentially return to this sector as economic recovery begins. However, if significant time has elapsed before the onset of an economic recovery, as illustrated in Figure 2, new capacity is expected to be skewed towards new hires, individuals returning from educational upgrades or from other industrial sectors. Those who have retired or retrained for new professions will be less likely to return. This non-recoverable technical capacity loss potentially poses an impediment to economic recovery. Consequently, efforts to reduce the permanency of such losses may help expedite economic recovery in that sector. The key question then becomes: Can academia help minimize non-recoverable capacity losses in the technical communities they serve? If so, how?

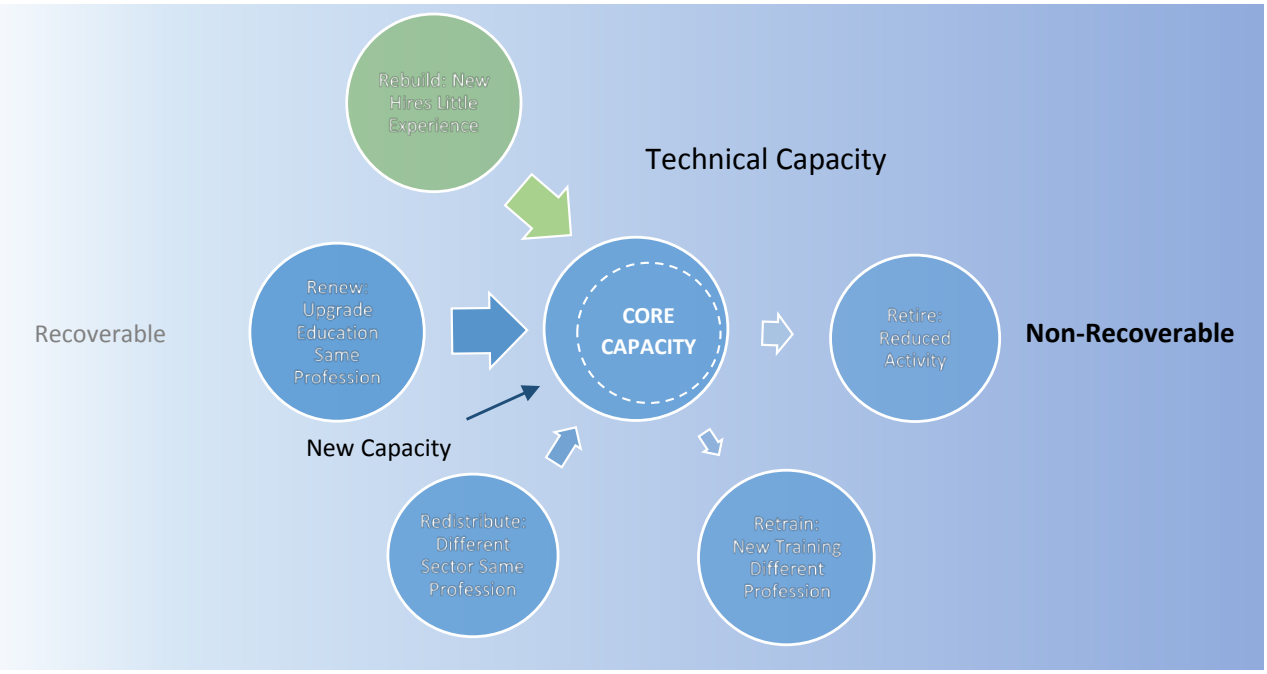

Figure 2: Rebuilding of capacity in technical community during onset of economic recovery.

Since individuals who permanently retire or retrain for a different profession are the primary source of non-recoverable losses of expertise, one way academic institutions can help sustain technical capacity is to work with the core industry group, as well as those in the process of retiring or retraining to help capture and preserve this knowledge and expertise. Ultimately, this captured expertise, in combination with new knowledge generated through R&D, can be crystallized in the academic institutional memory to ensure it is preserved and transferred to those returning to upgrade their education, as well as the next generation of students. However, it is critical that such knowledge capture activities take place early in the economic downturn phase, while departing individuals still have time and motivation to engage with academia. If too much time passes, information may become stale and difficult to access, and individuals move into different phases of their lives and lose interest in the sector.

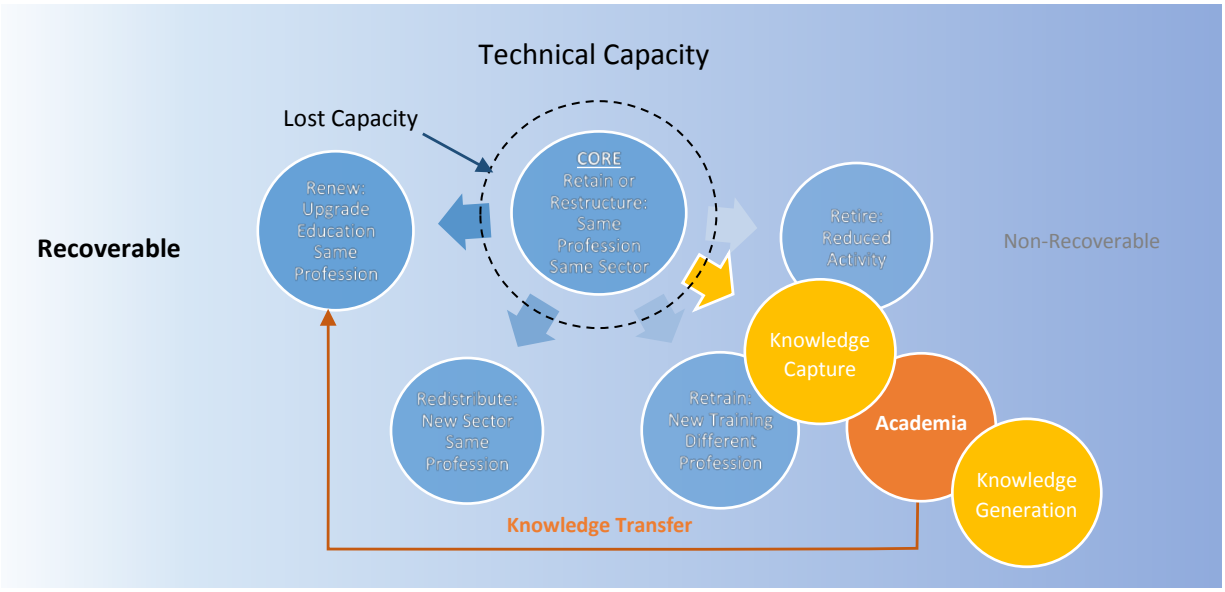

Figure 3: Knowledge transfer from technical community to academia during economic downturn increases recoverable capacity.

However, if successful, academic knowledge capture can help preserve and transfer such expertise back to the community core, as well as to new and upgraded professionals, as illustrated in Figure 4. This can ultimately accelerate capacity building and economic recovery by helping bridge gaps formed during the preceding economic downturn.

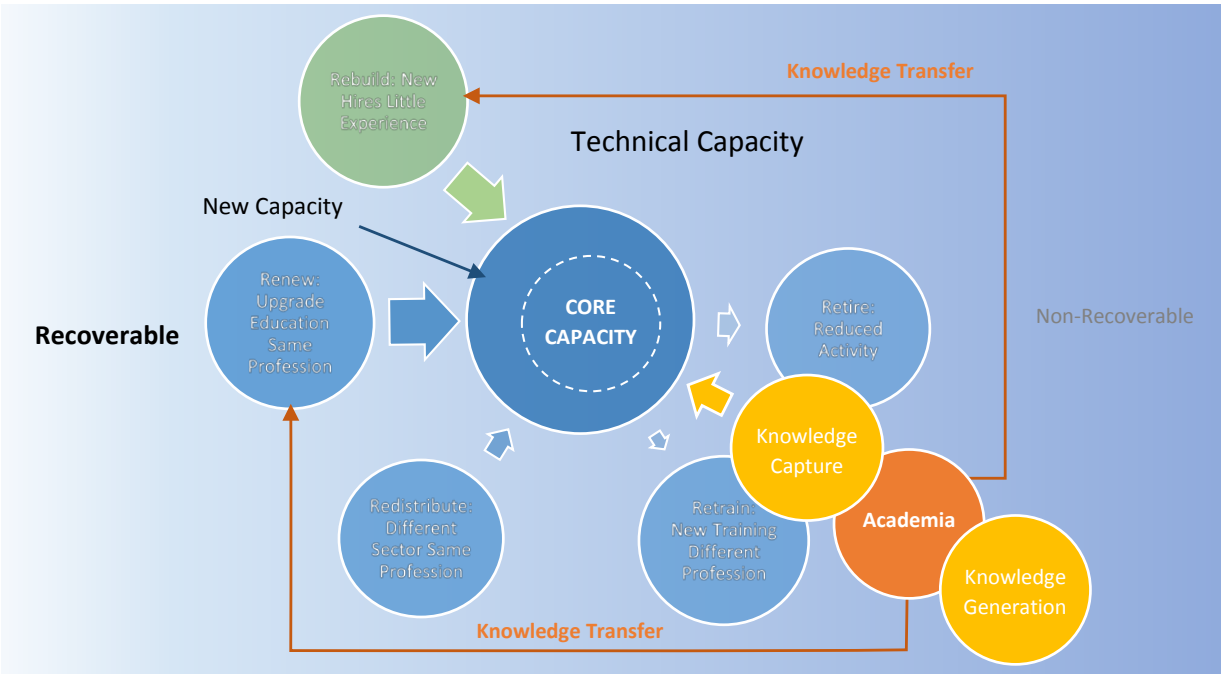

Figure 4: Knowledge transfer back from academia to technical community, as well as to new and upgraded professionals helps accelerate capacity rebuilding during economic recovery.

Discussions

Economic downturns can result in non-recoverable losses of knowledge, expertise and capacity in the technical community. Such losses are more significant for engineering disciplines having significant gaps in mid-career practitioners, as downturns eliminate windows of opportunity for seasoned professionals near retirement to mentor early-career professionals. Opportunities exist for academia to support building and maintaining engineering capacity in cyclical industrial sectors by creating improved mechanisms for transferring knowledge to academia during economic downturns. Such knowledge can be stored, advanced and subsequently transferred back to new and core practitioners during the onset of economic upswings to help accelerate recovery. Implementation of such systems in practice requires stable funding to support optimal approaches for knowledge identification, acquisition, development, sharing and distribution, utilization and retention[4]. While new knowledge generation (e.g. R&D) is supported by many national funding programs, far less funding is available for knowledge capture and management, leaving academia in a position where it could help, but does not have the resources needed to deliver this support. While it is evident that such knowledge capture initiatives could help build academic institutional memory and support economic recovery, further research is needed to identify specifically which types of mechanisms, management and support frameworks would be most effective. Ongoing research at Memorial regarding mechanisms for engaging industry, academia, technical societies and government agencies to help develop and implement such a knowledge capture and management system are ongoing.

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