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IAMOT and Education: Defining a Technology and Innovation Management (TIM) Body-of-Knowledge (BoK) for graduate education (TIM BoK)☆

Mario Yanez*, Tarek M. Khalil, Steven T. Walsh

University of Miami, School of Business, CIS Department, 421 Jenkins, Coral Gables, FL 33124, USA

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ABSTRACT

Whether it is called Management of Technology and Innovation (MOTI), Management of Technology (MOT), Engineering Technology Management (ETM) or Technology and Innovation Management (TIM), the TIM field is rapidly growing and diverse. This diversity is built upon disparate university locations of TIM programs; TIM's emerging nature, its wide appeal as well as unique researcher and practitioner viewpoints. This has created a plethora of education materials, benchmark programs and pedagogical thought. Yet the field is growing so rapidly that no single source has yet been established which clearly identifies which topics and educational materials represents its basic Body of Knowledge (BoK). If this is so, then there is cause for concern.

We review TIM pedagogy studies, TIM research, and the economic realities that initiated and continue to demand TIM education for managers. We leverage the five-year body of knowledge development activities of the International Association for the Management of Technology (IAMOT) education committee. We then develop a TIM BoK topic list and survey stakeholders that include: academics, industrial professionals and government policy makers. We found that there is a need for and convergence on a comprehensive TIM BoK source. The result is a TIM BoK source document that can be utilized to improve and monitor TIM educational programs around the world.

1. Introduction

Technology and Innovation Management (TIM) graduate educational degree granting programs are now more than 25 years old. The concepts developed in TIM undergraduate, graduate and postgraduate programs have proved so useful that they have transcended their own degree granting programs. Now nearly all management, engineering and many liberal arts schools have at least one course that covers management of technology and innovation topics in the programs they offer. Further, TIM topics are now often included in more traditional courses. Today TIM degree programs are called by a plethora of names including; Management of Technology and Innovation (MOTI), Management of Technology (MOT), Engineering Technology Management (ETM) and Technology and Innovation Management (TIM). Almost all provide courses in: technology management, technology strategy, technology-based entrepreneurship and technology-based social entrepreneurship (hereafter named technology entrepreneurship), technology innovation, creative enterprise management, technology forecasting and many others. We have chosen to hereafter in this paper use the TIM designation.

Universities that provide programs in TIM grew from an initial program, to approximately 150 programs by 2002 (Kocoaglu et al., 2003) and the number is still increasing. TIM degrees are so popular that universities from around the world provide them, but from a variety of different "homes" or schools. Universities currently bestow these degrees through dedicated Management of Technology and Innovation Centers, Engineering Schools, Schools of Science, Liberal Arts Schools and Management or Business Schools. Further, differing schools at the same university have come together to jointly offer joint TIM programs. Finally, in at least at one university there are two different schools which offer masters degrees that are some variant of TIM.

TIM programs are now established in North America, South America, Africa, Australia, Europe and Asia with leading scholars in the field calling these six continents with exceptionally differing cultures and economic needs their home. The rapid growth in TIM graduate programs, its global appeal and the disparate university home for the education programs has combined to generate dissimilarities in curricula development. There is what at best could be stated consensus by agglomeration without constraint in TIM education.

☆This paper is part of the ongoing efforts by IAMOT to assist in the development of standards for TIM programs.

* Corresponding author.
E-mail address: mario@miami.edu (M. Yanez).

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But how do we propose to generate the list of topics that should be included in a Technology Innovation and Technology Management Body of Knowledge (TIM BoK)? First, we consider the TIM research field by era in order to generate the rationale behind the interest in TIM and illustrate how this research supports the potential TIM BoK template topics. Next, two studies that focus on TIM pedagogy are considered.

We found that TIM research and pedagogy have mirrored the needs generated by the improved human condition. The Human condition improved at an unprecedented rate during the 19th and 20th centuries (Mansfield, 1968, Berman and Khalil, 1991, Schumpeter, 1909, 1934, 1939, 1942). Further, the transformation of the human condition was based not only on the rate of technological change but its magnitude. Technology and innovation has been the explosive force behind economic development and firm-based competitive advantage. Finally, managing this explosive change requires specialized education that has become known as TIM.

Many see the importance of technology change and innovation in business and the economy as a recent phenomenon, yet if you read some of the earliest management scholars we see references to its importance to firms and the economy in managerial literature as old as the field itself (Smith, 1776, Ricardo, 1817). But whether recent or not the continued dominance of technology change and its resultant innovations as agents of industry and societal change that foster the initiation, continuation, expanse and finally transformation of the industrial revolution into the knowledge base economy of today. Managing a wide variety of TIM elements relatively better through technology change has contributed to government- and firm-based success as demonstrated by the "Whiz kids" technology use in logistics for an army and in production for the US in WWII and at Ford after the war (Byrne, 1993).

The United States was perhaps the first country to understand the value of managing technology after WWII. The US was in a "technology race" with the Soviet Union as WWII ended (Byrne, 1993). This took the form of the race to space and other less savory elements of the "cold war." The United States (US) dominated the immediate post-WWII economy and dominated technology and innovation management research. Yet all was not going as well as it seemed for US-based technology firms.

The speed of technological change, the success of the Marshal plan (Behrman, 2008) in Europe and the MacArthur versions of those doctrines in Asia (Manchester, 1978) created a world of countries more focused on economic interdependence than economic independence. The success of these programs and other country led programs initiated post-WWII stability based on a more interconnected and interdependent worldwide economy. As envisioned the almost total US global economic dominance started to wane. US-based firm's loss market share in several industrial sectors during the 1970s and 1980s (Wheelwright and Hayes, 1985). This became a concern to government, industry and educators in the United States. The success of the global interdependence policies led to a rapid pace of technological change from many regions in the world and consequently, a shift in the balance of economic power to favor more countries all around the world.

Management educational practices and specifically technology and innovation management processes evolved to meet the needs of previous worldwide economic paradigms simply did not keep pace with new demands. The advent of new TIM education programs was academic world's response to enable highly effective future corporate and entrepreneurial professionals. Seminal work that helped define processes such as authors focusing on the diffusion of technology (Bright, 1964, Rogers, 1995), the management of innovation (Rosenbloom, 1978, Marquis, 1969), technologies effect on organization design (Woodward, 1965), technology strategy (Ansoff and Stewart, 1967), and technology policy (Arrow, 1962, Fusfeld, 1978) helped to define and initiate the field of TIM. TIM was born as an interdisciplinary field of knowledge integrating science, engineering, entrepreneurial, intrapreneurial, and management knowledge practices.

The field continued to evolve. The National Research (NRC) Council's task force on Management of Technology (NRC, 1987, Khalil, 1993) highlighted the multi-disciplinary nature of the field. They tasked the TIM field to link the above disciplines to produce among other things greater interdisciplinary education materials. They defined an educational charter to "plan, develop and implement technological capabilities to shape and accomplish the strategic and operational objectives of an organization." This early field convergence effort focused on capturing the value of technology and innovation in strategic; tactical; operational; and entrepreneurial, SME, and large firm organizational terms.

The TIM field is based on the anti-thesis of Keynesian equilibrium economics. TIM embraces the Austrian or Schumpeterian view of economics where change and in particular technological change causes disequilibrium-based opportunities. Most TIM professionals, then as now, provide that the essence of business opportunity is change. Further, the largest change agent in businesses is technology and its promise of economically important innovations. This is true whether you are in established or emerging economies, the firm is a large, small or medium enterprise (SME) or an entrepreneurial effort. Moreover, TIM research and pedagogy through focusing on technology in the service sector (Tien and Berg, 2003) seeks to radically improve management theory. Today we embrace the knowledge economy which is service intensive. Yet, we bring tools to those embraces which are largely based on information generated from physical products and specifically systems integrated or assembled products, theories that may not be useful in today's economy (Linton and Walsh, 2008a, 2008b). The emergence and embrace of the transformation of the industrial revolution into today's knowledge economy has different needs. Many of traditional management theories do not meet the challenges of the 20th and 21st century's knowledge based economy (Linton and Walsh, 2004).

TIM's response was to initiate improvements in nearly every aspect of managerial practice. This included efforts to incorporate technology into the strategic process of a firm (Friar and Horwitch, 1985), technology and innovations role in project management (Shenhar and Dvir, 2007; Project Management Institute, 2000), greater emphasis on operations and total quality management (Garvin, 1982, Deming, 1982) technology development (Shrivastava and Souder, 1987), R&D management (Mitchell and Hamilton, 1988, Souder and Rubenstein, 1976), technology forecasting (Porter et al., 1980, Ayres, 1969, Martino, 1983, Jantsch, 1969, Jones and Twiss, 1978), the impact of science and technology on society (Rogers and Shoemaker, 1971, Linstone et al., 2001), and many others.

Yet rigid institutional boundaries between not only programs but between university schools or "homes" especially engineering and business schools need to be softened (Badawy, 1995, Khalil and Garcia-Arreola, 1997). Nowhere was the need for cross-pollinating the technologist and managers more evident than in technology-based entrepreneurial efforts (Kirchhoff, 1994). "High tech" or perhaps more correctly stated "technology intensive" entrepreneurial efforts role in the economy was just being fully appreciated (Birch, 1987, Kirchhoff et al., 2002) and many others initiated research that demonstrated the enormous value that these firms provided society. They demonstrated entrepreneurs were responsible for the majority of job and wealth creation in the United States and postulated the same occurred around the world.