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National systems of Advanced Manufacturing Technology (AMT): hierarchical classification scheme and policy formulation process

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Abstract

Advanced manufacturing technology (AMT) is characterized by its complexity and diversity in terms of technical profiles and participating actors. Thus, the successful implementation of AMT necessitates the hierarchical coherence of national policy whereby industrial policy, development policy and utilization policy are consistently and interactively linked. Borrowing the notion of national systems of innovation, this paper introduces the notion of national system of AMT and describes the systematic procedure to develop the national AMT policy. In doing that, hierarchical classification schemes are proposed as the building block for stepwise policy formulation. It is highlighted that the criteria of classification schemes differ considerably and, consequently, different policy implications are drawn depending on the position in the national system. A three-stage policy making process is suggested in which industrial system, technology system and utilization system of AMT are formulated in a hierarchical and interactive manner.

Keywords: Advanced Manufacturing Technology (AMT); Classification; National policy system

1. Introduction

Advanced Manufacturing Technology (AMT) is defined as a comprehensive collection of technologies for enhancing efficiency and flexibility of manufacturing systems. During the last decade, AMT has received intensive attention from industrial practitioners and policy makers alike as the strategic importance of manufacturing competitiveness was keenly recognized. Both advanced economies and Asian developing countries have exerted massive efforts to generate and disseminate AMT in order to heal or mitigate the typical trauma of productivity decline and/or wage hike. Further, AMT has been highlighted as a synergetic catalyst of technological innovation, driving both forward- and backward-linkage effects across various industries.

Despite these earnest endeavors, the overall performance was disappointing. The reason may be attributable the following two factors. First, many firms, especially small and medium-sized firms, lacked the absorptive capabilities to internalize AMT due to managerial deficiencies and organizational obstacles (OECD, 1997; Park, 1999). Accordingly, the recent policy strand was directed to addressing the problem and such remedial measures as diagnostic/advisory services were provided extensively during the 1990s. Second, more seriously, national systems often suffered from structural discrepancy between technology generation (supply) and technology application (demand). This phenomenon is particularly true in developing countries, like South Korea, where the technology gap between generation capacities and utilization needs is wide. On the one hand, end-users of AMT, mostly private firms in the manufacturing sector, are competing in the global market with leading foreign firms and hence in need of up-to-date AMT. On the other hand, domestic suppliers, AMT makers and R&D institutes, lack the indigenous capability to meet the sophisticated demands. It is not uncommon that technology developers and technology users are separated from each other. Therefore, it is critical for the government to coordinate these diverse and even contradictory needs in developing national policy of AMT.

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Table 1
Hierarchical structure of a national AMT system

Hierarchy	Actor	Objective	Perspective
Top	Policy maker from Government	— Promotion of AMT industry — Positioning of AMT in market — Development of export/import strategy of AMT	Industry–Technology linkage
Middle	Researcher/Engineer from R&D community	— Creation of new technology — Systematization of unit technologies	System–Technology linkage
Low	Plant manager from private firms	— Enhancement of efficiency and flexibility — Compatibility with existing technology	Process–Technology linkage

Table 2
Selective set of AMT to be classified

Sensor, Hydraulic/Pneumatics, Motor, NC machines, Robotics, Control devices, AGV, AR/RS, CAD/CAPP, MRP, LAN, MAP, PLC, Simulation

This issue, however, remains a largely gray zone in research and policy practice. This article presents a systematic procedure to formulate the national policy of AMT. It represents the output of a preliminary study that serves as the blueprint of the large-scale policy formulation. The purpose of this article is not to report a detailed experience of real-world practice but to suggest an illustrative framework for prospective policy making. First, by borrowing the notion of national systems of innovation (NSI), the basic structure of national system of AMT is proposed. Second, based on the national system, hierarchical classification schemes of AMT are presented as a building block for formulating the national plan. Third, policy implications of classification are discussed. Finally, the overall framework of national AMT policy is suggested.

2. Hierarchical classification scheme of AMT

2.1. National system of AMT

By its nature, AMT necessitates integrating hardware and software, the technological and industrial origins of which are spread across mechanical, electronic, software and information/communication fields. Therefore, AMT can be considered as a technology–industry set composed of various elements, homogeneous in some aspects but heterogeneous in others.

In dealing with diverse objects with multiple dimensionality, a systems approach can be a useful tool. Particularly, the notion of NSI is borrowed to this end. NSI in general can be defined as the socio-economic profiles and technological determinants of a nation that are portrayed in a systematic way and underlie the innovation capacity and growth performance (Lundvall, 1992; Freeman, 1987; Porter, 1990). Therefore, NSI intends to draw the best-practice system of a nation that maximizes innovation capacity and growth potential.

In a similar vein, the notion of national systems of AMT is employed. The notion postulates that the national policy of AMT constitutes a hierarchical system consisting of three major components, overall industrial policy, technology development policy and technology utilization policy. Specifically, as summarized in Table 1, at the first and highest level exist policy makers who are mainly interested in industrializing AMT and determining the shape and position of AMT in the overall industrial structure. At the middle level are researchers and engineers who develop new technologies and/or systematize unit technologies. At the final and bottom level are plant managers who adopt and utilize AMT in the manufacturing process. Therefore, the planning committee consists of representatives from the government for industrial policy, R&D community for development policy and private firms for utilization policy. Furthermore, the perspectives of these primary actors are industry–technology linkage, system–technology linkage, process–technology linkage, respectively.

It is assumed that these three layers account for the primary actors of the national AMT system. The notion emphasizes that the success of AMT policy hinges on the hierarchical coherence and strategic consistency among respective layers. In other words, industrial policy, technology development policy and technology utilization policy need to be consistently and interactively linked in the national system.

2.2. Hierarchical classification scheme

Based on the basic structure of the national system, hierarchical classification schemes of AMT are proposed. The schemes represent an experimental exercise whereby policy planners from different layers are