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JONG-TSONG CHIANG

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Jong-Tsung Chiang

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Abstract

As the post-World War II history shows, several "diffusion-oriented" countries, Japan and Germany in particular, have performed better economically than some "mission-oriented" countries, like France and the U.K. As the leading "mission-oriented," innovator and "first mover" country with three decades' economic and technological dominance and impressive "spin-off" achievements, the U.S. has been eclipsed in its traditional competitive advantage by many "smart followers" which have strong technical resources and complementary assets, and could rapidly assimilate innovator's technical advances and compete away innovator's economic rewards. To revive, the U.S. Federal government is undergoing a structural transition in its industrial technology policy toward "diffusion-oriented" paradigm. This new trend also reflects the growing skepticism and even disillusionment about the conventional "spin-off" rationale. In "diffusion-oriented" policy framework, U.S. Federal government active participation in "generic" and "precompetitive" technology is a rather novel strategic movement in this country. However, there still are some delicate issues involved in, especially, "precompetitive" cooperative industrial R&D remaining to be solved.

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"Mission-Oriented" vs. "Diffusion-Oriented" Policies

In technology policy, the U.S., the U.K. and France could be described as "mission-oriented"countries, as compared with "diffusion-oriented" ones, such as Germany, Sweden and Switzerland, while Japan is a hybrid between both.[1]

Mission-oriented policy attempts to generate and exploit radical innovation. Its ideal is to create entirely new industries based on new technologies. So it tends to compete in the early phase of technology life cycle, and emphasize "heroic" efforts in "big science and technology," or major programs. These programs, mostly defense and aerospace-related, are highly sophisticated and normally put more emphasis on performance than on cost. It is expected that, in addition to accomplishing the designated missions, the large-scale, high-end technological achievements can somehow lead to many smaller-scale, "less than high-end" applications. More specifically, through government R&D contracts or procurements of high-performance products, the contractors can upgrade technical capabilities, accumulate production experience, and drive down the cost. They then seek commercial applications. By this "spin-off" or "trickle-down"[2] process to civilian industry, it is hoped that the government initial costly investment can ultimately be justified.

By contrast, diffusion-oriented policy concentrates on acquisition, diffusion and assimilation of technology in industry. It attempts to increase value-added for existing products by improving quality, increasing efficiency or entering niche markets, rather than to create brand new industries. Moreover, especially in Japan, lower cost and lower risk fields are normally first targeted, and then used as stepping stones to accumulate experience and economic profits for competing in the next higher-end products. So incremental innovation is emphasized, and there are few large scale programs initiated by government mission agencies aimed at radical technological advancement. Though moving toward earlier phases of technology life cycle is also pursued, the key notion of this policy is to be a "smart follower" first, instead of a "first mover" who risks the most. This is so-called "trickle-up." It also turned out that, in some fields, notably microelectronics, civilian technology thus cultivated could be largely used for military applications. This is the opposite of "spin-off," and may well be called "spin-on."

Comparatively speaking, "market-pull" plays a greater role in diffusion-oriented policy than in mission-oriented policy. In the latter case, government designated missions create initial markets, and "technology-push" then supports further "spin-off" or "trickle-down" activities, if any. In terms of innovation pattern, mission-oriented policy tends to focus more on product innovation (e.g., performance of key functional parameters), whereas diffusion-oriented policy tends to emphasizes more process innovation (e.g., efficient manufacturing).[3]

It is also worth noting that the mission-oriented policy of the U.S., the U.K. and France is connected to their national security policy seeking greater degree of technological self-reliance. These three countries' defense R&D expenditures as a share of total GNP are much higher than those of diffusion-oriented countries. As a result, the non-defense R&D shares in GNP of the U.S., the U.K. and France have constantly been lower than those of Japan and Germany for the past three decades. In the mid-1980s the ratio of the former to the latter in GNP percentage was about two thirds.[4]

As the post-war history shows, the mission-oriented France and U.K. have been less successful economically than the diffusion-oriented Japan and Germany. The large military efforts in the former countries have apparently not led to particularly favorable positions on civilian markets of high technology. However, the U.S. was an exception at least until the 1970s when its international competitiveness of some industries began to erode significantly.

U.S. Policy Principles and "Spin-off" Achievements

Based on a general consensus that government involvement in science and technology is to overcome market failures, especially low appropriability and capital market imperfections, that cause underinvestment in R&D, U.S. government traditionally only supports fundamental scientific research, just as all other developed countries do, and well-defined mission-oriented technological programs in which government has a strong and direct procurement interest. One of the very few exceptions in the history is the early agricultural R&D and extension program.

Because of lack of knowledge about commercial potential and reluctance to induce uneven distribution of benefits, Federal government basically follows free-market principles and leaves civilian technology development to private industry. Though some policy initiatives designed to expand Federal government role have been proposed for the past three decades, few of them were enacted or lasted beyond the initiating administrations' term of office.[5] So in the arena of industrial technology policy, the U.S. has a cumulation of mission-oriented programs, but lacks a comprehensive and strategically-oriented approach as compared with Japan and many West European countries. Besides, U.S. Federal government does not "pick winners" or purposefully nurture "national champions." This is a big policy distinction between the U.S. and many European countries as well as Japan.

During the three decades following World War II, U.S. "spin-off" achievements based on a number of mission-oriented programs were fairly impressive. Well-known examples include jet engines (for high-performance fighters and bombers), computers (for plotting missile trajectories), semiconductors (for missile guidance systems), numerical control (NC) systems (for carving out aircraft structural parts), lasers (for tank range finders and beam weapons), and time sharing, digital communications and computer graphs (for air defense system).[6]

As a matter of fact, the impacts of some U.S. "spin-off" cases, most notably semiconductors and computers, are extremely far-reaching. They have triggered "technological paradigm" change, and created a new constellation of basic technological artifacts and heuristics or intellectual principles which dictate the working protocols.[7] They have also induced "technology system" change, and brought about a range of technological and innovative activities