The case for industry leadership in Science, Technology & Innovation (STI) policy implementation.

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Abstract. Society typically relies on the industrial sector to supply product and service innovations through the free market system. When an area of free market failure is deemed important to society, governments intervene by applying alternative innovation systems. Governments routinely apply a procurement contract approach led by industry, in areas involving technology-based deliverables, such as military, aerospace and energy systems. In contrast, governments tend to apply an exploratory grant approach in biomedical and social service areas where the academic leadership's culture lacks progress milestones and defined deliverables. The latter approach expects that passive diffusion will somehow eventually transform scholarly findings into innovations with beneficial socio-economic impacts. This paper refutes this expectation and approach based on two factors: 1) The major global economies (European Union, United States and China) have narrowed the definition innovation to the context of commercial business markets; 2) The lack of evidence drawn from a specific market failure example; assistive technology devices for persons with disabilities. The conclusion being that all market failure areas at the intersection of science, technology and innovation should be re-oriented to follow the procurement contract approach led by industry.

Keywords. Assistive Technology, science, technology, innovation, invention, government, industry, academia, market failure, procurement contract, exploratory grant, policy, practice.

1. The Business of Innovation is Business

After decades of refinement, the European Union settled on a definition for the term 'innovation' [1], and the United States eventually adopted the same definition [2]. This shared definition is an important refinement because it restricts use of the term innovation to the context of products and related activities within the industrial sector:

> "An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices . . ."

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Of course, the industrial sector does not operate in isolation. It draws inspiration and support from government and academic sectors. Corporate demands for efficiency necessitate external expertise in methodologies (i.e., scientific research; engineering development), secure financial investment, and verify the presence of market conditions necessary to sustain a competitive business model [3].

The historical precedents for industry-based innovation typically represent business opportunities arising under the free market system, where companies can foresee a return on their investment. However, there are also instances of "market failures" where the private sector cannot make a compelling business case due to insufficient capacity to address the scale of the enterprise (e.g., military weapons; space exploration), or insufficient financial return on the required investment (e.g., fundamental scientific research; orphan drug development).

When governments view instances of market failure as critical to national interests they can choose to intervene through one of two alternative innovations systems:

1) Contractual Procurement System – A government agency sponsors the necessary R&D and specifies both the outputs to be generated and the performance parameters to be achieved. The contracting organization – typically an industrial corporation -- is chiefly concerned with delivering a product or service that that meets the government's specified performance criteria within the corporation's time and cost parameters. The Contract Procurement system supports relevant engineering development and industrial production activity, to achieve a pre-determined advance in the state of the practice to serve a national need. The sponsoring government agency often serves as both the R&D sponsor at the front-end (input) while serving as the primary customer for the project's deliverables (output).

2) Exploratory Grant System - A government agency sponsors the necessary R&D but the funding recipient – typically a university faculty member – determines the output to be generated by proposing a scope of work. A peer-review process involving other scholars determines the general merit of the area of conceptual knowledge to be advanced, while the government agency focuses on the quality and rigor of the activity conducted. The Exploratory Grant system typically scientific research intended to advance the state of global knowledge. The sponsoring agency provides the front-end

resources (input), but the academic community is viewed as the customer for the project's deliverables (outputs), which are typically embodied in scholarly publications.

These two alternative innovation systems can deliver the intended impacts for society when they are properly aligned to the intended mission. That is to say, problems requiring the delivery of products and services should implement the Procurement Contract system, while problems requiring the delivery of new conceptual discoveries should implement the Exploratory Grant system. This paper argues that governments consistently and mistakenly apply the exploratory grant system when intending to address the needs of people with disabilities and the elderly through Assistive Technology devices and services.

2. Innovation in Assistive Technology Devices and Services

The field of Assistive Technology (AT) is a clear case in point for four reasons: (1) As a small market it is easy to identify the organizations, actors, actions and resources that influence the state of technological innovation; (2) As a relatively new technology field one can see the relative contributions or constraints arising from the various economic sectors involved; (3) Lacking the private market forces of scale and profit, the AT field is a free market failure; (4) Most importantly, decades of government investment in the Exploratory Grant system have failed to produce outcomes with the promised beneficial socio-economic impacts.

The United States' National Institute on Disability and Rehabilitative Research has expended between $25 million and $50 million per year since 1974 on technology-oriented programs intending to improve AT devices and services. Similarly, the European Union's Framework Programmes have allocated several million dollars per year since 1984. Both the U.S. and the E.U. have consistently devoted the majority of resources to Exploratory Grant systems led by academic faculty within universities.

All told, multiple nations have channeled hundreds of millions of dollars into university coffers for the expressed purpose of generating new or improved AT products and services to improve the quality of life for persons with disabilities and older persons.

However, there is little – very little – evidence linking this sponsored activity to new or improved AT devices, or to increased access to AT services. Many of the projects cannot even demonstrate evidence of reaching the prototype stage, let alone resulting in transfers to the commercial marketplace [4].

During the same timeframe, the predominantly small private companies comprising the AT industry struggle to fund their internal R&D activity from the slim profit margins available through the third-party AT reimbursement system. These AT companies cannot afford to pay for scientific research beyond that required to meet health and safety requirements, and their engineering development is focused on lowering the costs of manufacturing and supplying their AT devices and services so they can afford to remain in business. If the public funding delivered to academia had instead been allocated directly to companies in the AT industry, they could have implemented improvements to their existing product lines as a return on the government investment.

The future looks equally grim elsewhere. Government-sponsored initiatives to address AT in other countries (i.e., Australia's National Disability Insurance System, and Brazil's National Research on Assistive Technology initiative), appear to be emulating the same mistaken approach. It should be no surprise that the same two economic sectors -- government and academia -- continue to promote the Exploratory Grant system. Unfortunately the results will follow the same observed pattern of expanding government agencies and supporting faculty scholarship leading to promotion and tenure, , while the AT companies and the intended beneficiaries will be left with little benefit from all the money and time expended.

3. Recommendations for Government Support of Assistive Technology

It is past time for policymakers and political representatives to insist on substituting a Contract Procurement system led by industry for the failed Exploratory Grant system led by academia. Under a Procurement Contract system in direct partnership with the industrial sector, the government would set the performance specifications for all types of AT, companies would bid to fulfill those performance requirements. Once designed

and tested by AT corporations, government would contract with those same AT corporations to manufacture, deploy and support the resulting AT devices and services.

Government would purchase and distribute these devices and related services within the domestic market. The government would also fund the Certified AT professionals to ensure that AT recipients receive the right devices, learn to use them and have a source of follow-along support. Access to free AT products and services would eliminate costs for entire third-party review and payment system, along with the associated medical and legal fees determining eligibility, all of which is funding that could be reallocated to the direct delivery and support of AT products and services.

This approach would channel public money toward the market-oriented efforts of the AT industry – supported by expertise from academia and resources from government -- to define and design the optimal AT products and services. It could be readily tested through a three to five year pilot project within a specific AT topic area.

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