Multidisciplinary Science as a Competitive Advantage

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Introduction

Michael Porter's research in economics has created the concept of "competitive advantage" [7]. A company possesses a competitive advantage when its profit exceeds the average of the industry. There are two types of competitive advantage: cost advantage and differentiation advantage. If the company delivers the same product than the competitors at a lower price, it possesses a cost advantage. If the company's product has certain benefits that exceed those of its competitors the company has a differentiation advantage. This concept can be migrated to the country level when an entire industry collaborates in order to achieve an industry wide competitive advantage in relation to the equivalent competing industries in other countries.

Scientific development is a national industry that clusters university and private research labs, state agencies, and private investors. Competing scientific industries in different countries both cooperate and compete for scientific achievements, resources and personnel. However, research is traditionally done within a single field, looking for improvements, optimizations and solutions for traditional problems. Scientists from different fields seldom work together. The result from multidisciplinary cooperation is often an innovative solution, and very seldom the creation of a new multidisciplinary science.

This essay presents a framework to use multidisciplinary science for development, and argues that the implementation of such a framework is a competitive advantage for societies.

Multidisciplinary Science

Current trends in innovation combine expertise from different fields in the creation of products and services. Examples are the context-aware health monitoring systems [1] or new materials with improved absorption of sun energy [2]. In both cases well established scientific traditions blend together in innovative products. In the first case Pervasive Computing meets Health Sciences. In the second Energy Production meets Chemistry.

In some cases the cooperation in multidisciplinary projects aims to explore the potential of new technologies, and often the outcome is unforeseeable and irrelevant. Such is the case for the health monitoring system, which despite a successful research the technology never left the academy.

Other cases aim at solving traditional problems. This is the case for the project regarding materials with improved sunlight absorption. These materials are likely to find a way out to the market and contribute to the efforts for clean energy harvesting.

Other common outcome from multidisciplinary sciences is the enrichment of the participant fields, especially of the participant researchers. Each field adopts part of the generated knowledge. But most importantly, the participating scientists expand their knowledge and give space to new ideas for cooperation between the fields. Nevertheless, new research fields, educational requirements and business opportunities are also outcomes.

Multidisciplinary cooperation usually takes a pragmatic approach: it focus on the products and methods of each field, instead of the fundamentals. They cooperate utilizing products in a new way or adopting methods from the other field. The fundamentals of each field remain untouched.

However, wide adoption of multidisciplinary endeavors faces many obstacles. First, researchers with the right combination of expertise lack in almost every society. Second, arguing how the combination of two fields will yield a relevant outcome and how to asses it is difficult. Third, scientific careers are normally built around a field, and the goal is to innovate within (it's difficult to see a professorship in robotics and chemistry). Among others.

Examples of Multidisciplinary Science

Bruno Latour presents an example [5] of multidisciplinary science in his ethnographic study of a neuroendocrinology research lab, following the transformation of TRF from a statement to a scientific fact. In the process we find two competing research labs looking for the molecular structure of the TRF releasing factor. Only after one of the groups changes its approach, using methods from chemistry, mayor discoveries are achieved and the structured of TRF is obtained.

In this case methods and tools developed and used in one field (chemistry) came to leverage the research in another (endocrinology), creating a new field (neuroendocrinology).

Another example is the UK e-Science Programme [6], it "*has supported the development of generic technologies, such as the software known as middleware that is needed to enable very different resources to work together seamlessly across networks and create computing grids*". The programme involves scientist from different fields, collaborating in the construction of a grid computing platform to support their research.

This is a case where the necessities and requirements of one field (chemistry, biotechnology, engineering, etc), are taken as design input in another (computer science).

The Framework as a Competitive Advantage

A framework for fostering and capitalizing the gains of multidisciplinary scientific research into products and services builds on the second kind of competitive advantage (differentiation). The collaboration of multiple fields in the creation of a product gives it unique benefits that differentiate it in the market.

At the country level, the framework itself is a competitive advantage if it continuously creates competitive industries. The framework sets the difference in the way a society approaches the innovation necessities of its local industry.

Development Framework

The framework is presented as a flow of activities, a set of actors, few prerequisites, and general principles.

Prerequisites

Development frameworks like the World Bank's Comprehensive Development Framework – CDF [3] fail at establishing as prerequisites things that ought to be considered as goals of any development effort. Take for instance CDF's "Social Safety Net and Social Programs" requirement. For a developing economy that seeks to ignite growth, the development of extensive social programs is a moral obligation, but might be a strategic mistake. A substantial part of the money thrown into subsidies could be invested in other priorities that will have a better return in the long run.

Rodrik analyzes the phenomena [4] and proposes the Theory of The Binding Constrains for countries with limited resources and leaders with finite political capital. Rodrik theory helps leaders optimize the utilization of political capital in the implementation of reforms, investments and policies that foster sustainable development. Rodrik's approach diverges from the orthodoxy as it treats the otherwise prerequisites as the goal for which policy is created.

The current document does not discuss policies, or other necessary aspects of development. However, it asks for some requirements for its implementation. The maturity level to which these requirements are implemented might not be advanced, but at least acceptable. The requirements are the following:

- Freedom of Association: mentioning this is just to make clear that the framework has no application in tyrannies.
- Market Economy: With as few distortions as possible (price controls, monopolies, high inflation, high interest rates) it serves both as the marketplace for the new industries and as a validating tool for their success or failure.
- Functioning Judiciary System: It's necessary to have an expedite judiciary system in order to settle down business disputes and assist in the seamless dismantling of failed companies.
- Accessible Financial System: It provides the resources and backing for proved companies. In this way the incubating responsibilities and resources of the state can be invested in new industries.

Principles

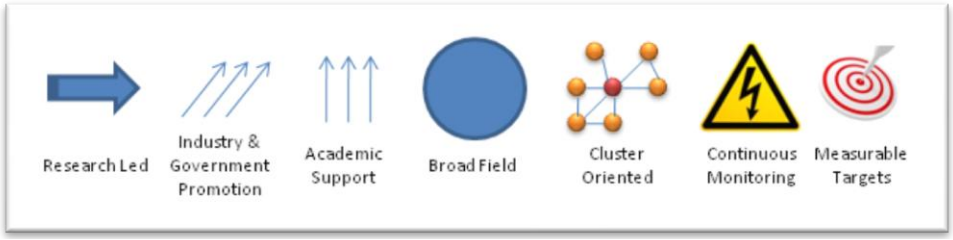

Fig. 1. Principles of the framework.

The implementation of the framework requires adoption the following principles:

- Research Led: The research community uses scientific rigor to point out the opportunities for multidisciplinary research.
- Industry + Government Promotion: Both parties participate in funding the projects at different stages.
- Academy Support: Associated universities provide highly specialized personnel both in technical and managerial issues.
- Cluster Oriented: The new industries should be organized as clusters of companies, so that the risk of the whole industry failing is compensated by the flexibility of each small company to adapt itself and overcome difficulties.
- Broad Target Field: The creation of industries should be done within a broad field like Clean Energy or Biotechnology, so that new industries can make use of existing infrastructure, join existing value chains, and complement existing ones.
- Monitoring: All participants are responsible for monitoring weaknesses, strengths, threads and opportunities in the new industries.
- Measurable Goals: Company level goals that are measurable and time limited need to be set. So failures can be detected early in the process, and corrections be implemented.

Activities

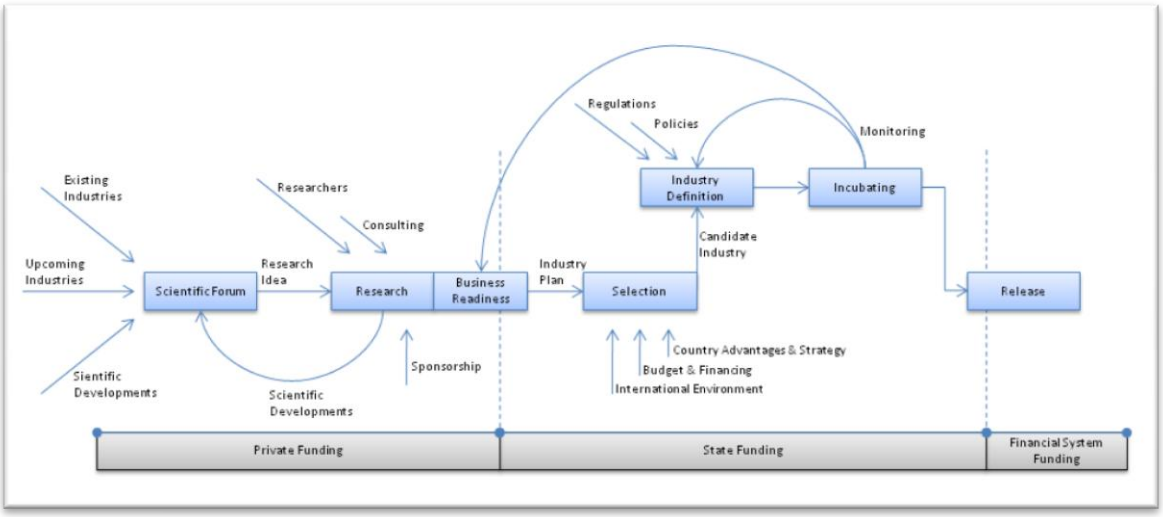

Fig. 2. Activities that make up the framework.

The following list details each of the activities:

- Scientific Forum: The forum identifies cooperation opportunities between sciences. It's led by the academic community in cooperation with the private sector. The forum receives as input the analysis of upcoming industries and technologies, and future business opportunities. The forum has the ability to use many tools, e.g. organize focus groups, invite consultants, run workshops, and travel to other settings. The forum requires being open to the public, and students, entrepreneurs and academics must use it to propose ideas, and find support on how to mature them. The outcome is a research idea that has the potential to create a new industry, funds for performing the research and the researchers to carry it out. This activity is privately funded and run, so government policy doesn't affect the creative process.
- Research: Researchers from different fields come together to work on the idea proposed by the Scientific Forum. The research is privately funded and the aim is to propose products that can be commercialized, and companies and industries created around them.
- Business Readiness: The products are evaluated in terms of their market potential. A potential industry is outlined in terms of participants, markets, chain value and resources. Business consultants from both the private and academia work together to produce an Industry Plan. This plan covers the companies to be created, the way they cluster, and how they fit the existing clusters. The plan also identifies potential spillovers and demonstration effects, and defines a sunset clause so that financial and human resources "*do not remain tied up for a long time in activities that are not paying off*" [4].
- Selection: Governments, in close cooperation with the industry decide in which Industry Plans to invest. Several things are taken into account: the comparative advantages of the country, the government's strategy for growth, the budget constraints, the international environment and the identified potential spillovers and demonstration effects. Mistakes of "picking the looser" will occur and the idea is to minimize them by following the proposed framework.
- Industry Definition: Government, Industry and Entrepreneurs define the Regulations and the Industrial Policy, e.g., tax incentives, special import/export mechanisms, labor regulation, etc.
- Incubating: Entrepreneurs are supported in creating new companies, establishing industrial relations, and making connections. The funding comes mostly from the private sector, however governments fund specific "new activities" that were non-existent before. These new activities are the result of the multidisciplinary research.
- Release: The company leaves the incubation phase after the parameters of the sunset clause are completely overcome. The release can happen as a public IPO, or a total buyout by the solidary sector (employees) or private investors.
- Monitoring: This activity is continuous and all actors are to perform it, having to look at the environment in terms of competitors, regulations, markets, human resources, and anything that could impact the incubating industries. The outcome takes multiple shapes like the necessity of certain kind of professionals, or of new markets.

Actors

	University	Government	Industry	International Institutions	Civil Society	Financial System
Scientific Forum	X		X			
Research	X		X	X		
Business Readiness	X	X	X			
Selection		X	X			
Industry Definition		X	X		X	
Incubating	X		X			
Release		X				X
Monitoring	X	X	X	X	X	

- University: Universities form groups of researchers in several fields. These groups are linked directly with the management, and shape the research and academic agenda of the institution. Universities lead the Scientific Forum and Research activities, and educate the scientific personnel needed.
- Government: Governments designate an existing agency with demonstrated competence for running the framework, providing it with enough decision power to make expedite decisions, and ties with both the private and academic sectors to establish a harmonic cooperation. The agency is the orchestrating and ultimate responsible of the framework, and specifically of the Selection and Business Readiness activities.
- Industry: Existing industrial associations provide funding for the Research and Incubation activities, and consultancy for the Business Readiness activity. It also provides input to the Scientific Forum and Industry Definition activities.
- International Institutions: They provide funding to the research and information about the international environment.
- Civil Society: The civil society is particularly active in the Industry Definition and Monitoring activities, checking on how the investments are being decided and emphasizing accountability for the mistakes.
- Financial System: It supports the Releasing activity by guaranteeing the flow of credit after companies finish the incubation period.

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