

The Development Process of Large-scale Science Data Infrastructure

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1. Introduction

The construction of Large-scale Science Data Infrastructure (LSDI) would not be complete without some remarks on important matters. While the development process of LSDI is intended to benefit all proponents of international infrastructures throughout their deliberations, it should be of greatest value during the critical period when serious negotiations involving potential funders are about to begin. The existing advisory process unlikely to suffice for implementing a large infrastructure that is characterized by the complex, long-term legal and financial requirements that the subject of this paper. Therefore, this paper is based on the analysis of existing and planned large research facilities.

2. Traditional construction of LSDI

The long and productive history of international collaboration by scientists is a strong incentive and precedent for establishing new, large global-scale projects. While the benefits of international planning and implementation can be significant, due attention must be given to the potential complications, among them:

- Delays and expenses associated with protracted international negotiations, and the necessity of involving non-scientific experts;
- Adoption of sub-optimal technical solutions due to sourcing/contracting requirements, or multiple sources for components of the infrastructure;
- Creation of sub-optimal financial or organizational arrangements due to the diverse reporting, oversight and authorization requirements of international partners;
- Exclusion/isolation of certain national scientific communities whose countries are not part of the collaboration;
- Inhibition of competition in scientific fields where it has traditionally been vigorous and productive;
- Creation of new administrative structures that may take time to come up to desired standards of efficiency;
- Potential transformation of large international infrastructures into conservative, self-perpetuating entities that may not respond optimally to new scientific needs.

Given these complexities and potential pitfalls, great care must be taken when undertaking any international project.

3. Legitimate and Managerial Issues

3.1. Legitimate/managerial structures, and governance

The term "governance" encompasses the set of structures, principles, rules and procedures through which collaborations operate, and through which decisions are made by the parties to the collaboration. One of the most important decisions regarding a large infrastructure is its fundamental legal/administrative structure. The elements of governance are depicted in the figure. Depending on the nature of the new infrastructure, different legal/administrative structures may be appropriate for the successive phases of the project (R&D/design, construction, commissioning, utilization, decommissioning). This is because the requirements could be quite different in such matters as financing, management, and oversight.

3.2. Creating a new structure/organization versus using an existing one

The importance of judiciously selecting the Host and site of a research infrastructure is universally recognized. The selection involves two key linked issues: whether to choose an existing physical laboratory location versus a new "green field" site, and whether to take advantage of an existing legal/administrative entity or create a new one that is tailored to the international collaboration.

3.3. Negotiations

There is a paradox that pervades the issue of how to organize negotiations of an Agreement to establish a Collaboration: the participants should be of an elevated rank/authority in their respective governments or institutions, so that they can make necessary decisions and proceed expeditiously; on the other hand, the participants must have the time and perseverance to deal with the many detailed issues and questions on which agreement must be reached. Thus, it is important to allocate topics to the right negotiators. Typically, only senior officials have the authority, skills and experience that are needed for such negotiations to succeed. The consequences of delaying negotiations can be damaging: momentum can be lost, high-level officials can turn their attention to other projects, potential funds can vanish, national administrations and policies can change. More and more, by many accounts, site selection for an infrastructure can be an extremely difficult and time-consuming phase of the international negotiations. If a "neutral" location of the site is imposed by science itself then considerable simplifications can occur, even though the selection of sites for manufacturing, operations, or headquarters facilities may still present challenges to the negotiators. If, however, there is no intrinsic reason why the infrastructure should be physically located in a particular place, there is a need to anticipate the strong involvement of non-scientists in the final decision-making. During the negotiations, an auction-like competition will likely be organized to select the HOST country, with proposals (including an inventory of amenities to be contributed, e.g. buildings, furnishings, staff positions, tax and customs exemptions, etc.) submitted by the competing countries. The results will determine, among other things, the amount of the premium to be paid by the Host, thus lowering costs for the non-Host Partners.

4. Funding and Contributions

The initial stages of international discussions about a large international infrastructure will focus on the scientific nature of the project, the general characteristics of the project site, and a preliminary cost estimate. As the discussions

advance and a seriously committed set of potential Partners emerges, an accurate cost will have to be agreed on, as well as the details of the financial rules and procedures. The goals of these advanced discussions concerning funding and contributions will be:

- To agree on the total cost of the infrastructure.
- To agree on how contributions will be provided.
- To arrive at an agreed scale (formula) of contributions from the Partners. Historically, large international research projects have been funded using a wide variety of schemes.
- To define the successive phases of the undertaking including any variations in the financial arrangements during these phases.
- To conduct a financial risk analysis that will inform them about the probabilities and consequences of potential perturbations to the nominal work plan and financial arrangements.
- To decide on how the operations of the completed infrastructure will be financed, including the handling of external income, if any.
- To define any special contributions or conditions that will apply to the host country or region (“host premium”).
- To define operating costs, and scientific access to the infrastructure.

5. Project Management

Large, complex and costly research facilities such as accelerators, nuclear reactors and telescopes have, historically, been difficult to manage successfully, even though they are, in principle, no more intractable than other civilian projects of comparable (or even bigger) size, such as dams, bridges, power plants or oil refineries. Standardized, proven, commercial software, and contractor services are available for supporting the management of large infrastructures. They are designed to facilitate the monitoring and coordination of multiple tasks that must go on in parallel and come together smoothly at critical states of the project. Contracting for these commercial services is costly. Three considerations should be kept in mind: (1) some Partner countries may already have standard management tools and procedures that they use for large projects; accordingly, negotiations will be needed to choose a set of consensus tools; (2) any analyses and projections will only be as good as the real-time data that they are based on – therefore, the Partners and sub-contractors must be willing to provide reliable information about the status of the sub-tasks that they are responsible for; (3) the Organization staff cannot simply offload the entire management task to a contractor, because they are responsible for the overall project and have the specialized knowledge that is needed for making key decisions. During negotiations between the Partners, project management modalities should be discussed, because they are linked to the type of legal administrative structure that is chosen, and to the arrangements for funding and contributions. If the Organization staffs are to assume primary responsibility for overall project management, they must be endowed with the necessary resources and authority, and they must have access to real-time data about the status of all sub-tasks, even if this involves intrusive inspection of the work of national laboratories and/or industrial contractors.

6. Equipment

In establishing the infrastructure, the Partners must decide about the ownership of the equipment. Typically, the Organization will be the legal owner, so there must be a process associated with a transfer of title of in-kind equipment. The Organization will presumably be provided with the result of tests and measurements as proof that technical specifications and requirements have been met, but it may want to require that a final set of tests be performed on-site, with the new components integrated into the bigger physical infrastructure. Personnel of the Organization will be in charge of these measurements, and will authorize the change of title, but care must be taken to avoid conflict-of-interest situations if the staff members concerned have a personal link to the institution that manufactured the equipment. If the equipment malfunctions during operations, rules and procedures should be in place to address responsibility and liability. Issues of liability for damage to persons and other equipment should also be considered. This requires some discipline during the time when the total cost of the infrastructure is being defined, since it, naturally, raises that cost.

7. Personnel

“Staffs” are persons employed by the Collaboration, not by the home institutions of the Partners. In recruiting members of the Staff, scientific/technological excellence will be a necessary. Thus, there may be considerations of geographical/national balance, international contacts and experience, linguistic skills, familiarity with the laws and procedures of the host country, etc. The makeup of the staff, and certain terms of employment, could be subject to special conditions agreed to during the negotiations among the Partners, particularly during the site –selection phase. The partners must decide whether recruitment of Staff is to be entrusted to the Collaboration, or whether it is their own responsibility to select nationals that will become employees of the Collaboration. If the former option is chosen, sufficient resources have to be allocated.

8. Conclusion

The development process of LSDI should be the results of strategic, long-term, policy-relevant planning exercises. Many successful guidelines are available for analysis and review, and it has been found that they display a wide diversity in terms of rationales, scope, and process. It may be up to the application of the development process to success in LSDI. The difference of method or mar is down to methodology. This paper presents essential particulars as well as main facts in LSDI. Henceforth, the development process of LSDI should be defined its specific-concrete theory through best practices.

9. References

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