Fermi National Accelerator Laboratory

FERMILAB-Conf-92/154

A Conceptual Framework for Using DOE 5700.6C and the Other DOE Orders as an Integrated Management System; the Fermilab Experience

Mark Bodnarczuk

Fermi National Accelerator Laboratory
P.O. Box 500, Batavia, Illinois 60510

June 1992

Presented at the 19th Annual ASQC National Energy and Environmental Quality Division Conference, Orlando. Florida, Sept. 20-23, 1992

Disclaimer

A CONCEPTUAL FRAMEWORK FOR USING DOE 5700.6C AND THE OTHER DOE ORDERS AS AN INTEGRATED MANAGEMENT SYSTEM; THE FERMILAB EXPERIENCE

Mark Bodnarczuk
Manager, Quality Assurance and Conduct of Operations Office
Fermi National Accelerator Laboratory[1]
P. O. Box 500
Batavia, Illinois 60510-0500

Abstract

In this paper, I describe a conceptual framework that uses DOE Order 5700.6C and more than 140 other DOE Orders as an integrated management system - but I describe it within the context of the broader sociological and cultural issues of doing research at DOE funded facilities. The conceptual framework has two components. The first involves an interpretation of the 10 criteria of DOE 5700.6C that is tailored for a research environment. The second component involves using the 10 criteria as functional categories that orchestrate and integrate the other DOE Orders into a total management system. The Fermilab approach aims at reducing (or eliminating) the redundancy and overlap within the DOE Orders system at the contractor level.

Background

In the closing remarks of the paper I presented at the 1991 National Energy Division Conference I suggested that QA professionals in research environments needed to move away from the old, tired, QC, "widget" mentality and towards a total management philosophy that was more performance-based.[2] I outlined two components of this shift in focus. The first was the need for tailored implementation guidance for applying DOE 5700.6C to research environments. Since last year, this document has been issued.[3] The second component was a unique mechanism that was being developed at Fermilab that would orchestrate and integrate the DOE Orders into a

[1] Fermi National Accelerator Laboratory (Fermilab) is operated by Universities Research Association Inc., for the United States Department of Energy (DOE).

[2] See Mark Bodnarczuk, "The Application of 10CFR830.120 in a Basic Research Environment," published in *The Proceedings of the Eighteenth Annual ASQC Energy Division Conference*, Danvers, Massachusetts, October 6-9, 1991, Session 3C, pages 3.1-10.

[3] See the *DOE Office of Energy Research (ER) Implementation Plan for DOE 5700.6C Quality Assurance*, issued May 11, 1992. In the memorandum of transmittal for the Implementation Guide, William Happer (Director, Office of Energy Research) states "I believe that the Implementation Guide captures the full intent of DOE 5700.6C as it is considered applicable to the research community. It provides the guidance needed to reasonably implement the intent of DOE 5700.6C and yet preserve the independence of the research community to creatively pursue the advancement of science." See William Happer, to Distribution, DOE Order 5700.6C Implementation Guide for Research, May 11, 1992.

total management system. In what follows below, I describe a conceptual framework that uses DOE 5700.6C and more than 140 other DOE Orders as an integrated management system - but I describe this framework within the broader context of the sociological and cultural issues of doing research at DOE funded facilities. My claim is that incorporating *both* components into the Fermilab QAP (the DOE-ER guidance and the use of DOE 5700.6C as an integrating function) has enabled the laboratory to move toward a more realistic total management philosophy that tailors the implementation of DOE Orders and is ideologically compatible with the traditional scientific culture at Fermilab.[4]

Internal and External Cultures and DOE Orders

While it is common to hear people discuss the notion of "cultural" change within DOE funded research facilities, most of them do not seem to have more than an intuitive understanding of what a culture actually is. In this section, I will attempt to concretize some of the aspects of culture using the scientific culture (primarily high-energy physics - HEP) as an example.[5]

Governments around the world provide the vast majority of money used to perform basic research. No matter which country's model is studied, these processes can evoke an image of an overall "research system" constituted by an interconnected chain of decisions.[6] At one end of the chain of decisions is the total sum of money available for performing all science. The decisions at this end are made largely by the political process. At the other end of the chain, are judgements about matters like the content of scientific publications or which specific research programs and experiments to perform. These decisions have historically been made solely by scientists. It has been very problematic to define a single model for managing the entire chain for a number of reasons. First, as already described, the decisions at both ends are made in very different ways (political processes vs scientific peer review) and are motivated by very different agendas (utilitarianism vs obtaining knowledge for its own sake). Second, there has been much discussion about whether there *are* definable boundaries between the two ends or whether the chain of decisions constitutes a continuum. Third, there are numerous issues about when people at one end of the continuum should affect decisions at the other end. In other words, what is the scientist's role in defining science or funding policy, and what is the government's role in defining how (or what) research should be performed.[7] In what

---

4 It should also be noted that the Fermilab Tiger Team Assessment Report endorsed Fermilab's approach to QA by stating that "Fermilab has established a plan that provides a structured approach to implementing a quality assurance program that will provide a value-added benefit within the research environment." See the *U.S. Department of Energy Office of Environment Safety & Health Tiger Team Assessment Fermi National Accelerator Laboratory*, May-June, 1992, Section 4.5.2 Quality Verification, 4.5.2.1 Overview, page 4-20.

5 One example of a cultural approach to science is Sharon Traweek's ethnographic study of the high-energy physics community at SLAC from the perspective of a cultural anthropologist. See Sharon Traweek, *Beamtimes and Lifetimes; The World of High Energy Physicists*, (Cambridge, MA: Harvard University Press, 1988).

6 This model is discussed in Steven Yearley, *Science, Technology, and Social Change* (Boston: Unwin Hyman, 1988), pp 77 ff.

7 Richard Stone recently described instances where scientific projects that had already been approved for funding through the peer review process, got caught in the cross fire between the

follows, I will describe why the problem of defining a single model for managing the entire research system is even more complicated than appears in the description presented above.

In the early 1960's, Alvin Weinberg developed a model for establishing priorities for scientific funding. Weinberg made a distinction (boundary) between internal (scientific) and external (social) criteria for scientific funding.[8] What is important to note about Weinberg's model *is not* the fact that he defined criteria for deciding on science funding. The important issue is that Weinberg's model defines a boundary between *internal* and *external* criteria without conjuring up the image of a linear chain of decisions. Conceptualizing the research system in terms of an internal and external model paves the way for characterizing science in terms of cultural differences that are inside and outside a given scientific field.

Also in the early 1960's, Thomas Kuhn's *Structure of Scientific Revolutions* characterized science using a profoundly sociological and cultural model. Kuhn claimed that the emergence of a scientific culture could be described in terms of the development of a scientific paradigm (disciplinary matrix) for that scientific field.[9] The culture-paradigm is constituted by a strong network of conceptual, theoretical, instrumental, and methodological commitments which includes things like traditions of experimental measurements, traditions about the great people of science, preferences for specific detector types, preferences for specific types of demonstration (golden events vs high statistics measurements), and preferences for specific types of experimental practices. Kuhn claimed that the culture embodied in the paradigm was transmitted to the next generation of scientists by the rigid paradigm-based training that students received from science textbooks and laboratory exercises.[10] During their training, students learn things like a shared vocabulary, beliefs about the physical world as studied within the paradigm, and (most importantly for our study), beliefs about how the *practice of science should be conducted.*

But what does all of this have to do with DOE Orders? My claim is that the cultural-paradigmatic *internal* beliefs and practices of HEP interact with the cultural-paradigmatic *external* beliefs and practices of DOE (many of which come from a nuclear or naval nuclear background) at the interface of managing DOE funded laboratories using the management systems prescribed in DOE Orders. Consequently, if the management systems prescribed in numerous DOE Orders are not substantially tailored for the activities of science, the practices upon which the DOE Orders are based are presented to researchers as an alternative set of beliefs and methodologies for how the *practice of science should be conducted.* While examples are myriad, Sharon Traweek points out one of the more interesting ones.[11] Traweek describes how

---

funding axes of the Bush administration and members of congressional committees. See Richard Stone, "Peer Review Catches Congressional Flak" in *Science*, vol. 256, 15 May, 1992, p 959.

8 Alvin Weinberg was then Director of ORNL. He claimed that the internal criteria should answer two questions. First, is the field ready for exploitation. Second, are the scientists in the field really competent. Weinberg claimed that these decisions could only be made by scientists. He identified three external criteria: technological merit, social merit, and scientific merit. The criteria of scientific merit assessed the degree to which the knowledge produced by the discipline requesting funding contributed to its neighboring scientific disciplines. See Alvin Weinberg, "Criteria for Scientific Choice" in *Minerva*, vol. 1, 1963, pp. 159-171.

9 Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 2nd ed. enlarged (Chicago: University of Chicago Press, 1970), pp 19-20

10 Kuhn, pp 19-21, and pp 136 ff.

11 Traweek, p 117 ff.

important the oral tradition is to the transmission of cultural beliefs and practices of a scientific discipline and to preserving the cultural boundaries of that scientific discipline. The issue of an oral tradition in science is interesting largely because this is in conflict with the belief within the DOE culture that the vast majority of activities should be formalized and proceduralized.[12]

With the recent proliferation of DOE Orders, two crucial issues arise. *First*, will the application of the management systems in these Orders substantially transform or exterminate major aspects of the scientific culture once they are implemented? I believe that this could happen unless the scientific community moves far more aggressively toward conceptually translating these DOE Orders into indigenously understood management systems like the DOE-ER Implementation Plan for DOE-5700.6C. Once one possesses these conceptual translations of the DOE Orders, the *second* crucial issue is the need for a conceptual framework that functionally integrates them. I will use the notion of function in roughly the same sense originally developed by Lawrence Miles.[13] Miles was in management at the General Electric Company in the mid-1940's and could not obtain the parts needed to produce appliances due to military and war demands for parts. Miles began to redesign these appliances but started thinking about the components in terms of their function, not their part number. When this type of functional analysis is applied to an activity or system, it aims at understanding the basic purpose of each expenditure, whether it be for hardware, the work of a group of people, or a written procedure. The issue is determining what that piece of hardware, group of people, or written procedure contributes to the overall performance of the system. The goal of functional analysis is to eliminate redundant functions that do not positively contribute to the overall performance of a system or organization. The Fermilab approach described below aims at reducing redundancy within the DOE Orders system at the contractor level with a bottoms-up *functional* harmonization. The goal is to collapse like functions together and not simply go through the DOE Orders like an ancient literary scribe, atomizing each phrase in the text line-by-line.

DOE Orders as an Integrated Management System

When I was tasked to be the primary author of the *DOE Office of Energy Research Implementation Plan for DOE 5700.6C Quality Assurance*, I carefully re-read DOE 5700.6C including the attached implementation guide and I noticed that the general requirements section of DOE 5700.6C invoked the requirements of DOE 1324.2A (Records Disposition). This raised the question about whether it was necessary to have *two* documents and records programs - one to satisfy the requirements of DOE 5700.6C and another one to satisfy the requirements of DOE 1324.2A (Records Disposition). It seemed that if one implemented the requirements of DOE 1324.2A and DOE 1324.5 (Records Management), that there was no reason to implement a *totally separate* documents and records program to satisfy the requirements of criterion 4 (Documents

---

[12] The problems of developing an integrated management system for DOE sponsored science are described by Crease and Samios who recall how General Leslie Groves just took it for granted that, given the source of the money and nature of the project, the Los Alamos facility would follow conventional practice and be militarized. But key scientists refused to come to Los Alamos under conditions of military hierarchy and bureaucracy which they claimed were antithetical to the spirit of science. See Robert P. Crease and Nicholas Samios, "Managing the Unmanageable" in *Atlantic Monthly*, January, 1991, pp 80-88.

[13] Lawrence Miles, *Techniques of Value Analysis and Engineering*, 3rd ed. published by Eleanor Miles Walker, Executive Director, Lawrence D. Miles Value Foundation, 1989.

and Records) of DOE 5700.6C. The question was, how many other requirements of DOE Orders were redundant and overlapping in a similar way.

The statement is often made that contractors and DOE personnel should comply with DOE Orders. But this seems like a tautology if a laboratory does not have a formally transmitted list of *which* Orders are imposed on it, i.e., if a laboratory does not know which Orders apply to them and have not read them, *it is not possible* for them to be in compliance with them. In discussions with Fermilab's DOE Batavia Area Office (DOE-BAO), I discovered 1) that all of the DOE Orders are listed in DOE Order 0000.2D Attachment I, 2) that Fermilab did not receive a list from BAO that describes which of these Orders should be implemented, 3) that such a list had been under development by DOE-BAO and Fermilab since the later part of 1990, and 4) that it would soon be formally transmitted to the laboratory.[14] Following the publication and transmittal of the first list of Orders in April 1991, I began the process of reading more than 140 DOE Orders and SEN's imposed on Fermilab through its M&O contract. I did not have to read too many before being totally overwhelmed by the fragmentation and duplication that typifies their content.

Reading the Orders and SEN's I discovered a number of problems. First, at the higher level the organizations that write the Orders often write them in isolation from other DOE organizations. The Orders have a vertical (tops-down or bottoms-up) path but there appears to be little or no cross talk horizontally between the organizations that write these Orders. Second, the Orders often define an "organizational context" so that it makes sense to the reader, but these sections normally re-invent the wheel with numerous redundant requirements. Third, it is as if the Orders project a virtual image of the (vertically) isolated organization through the document in terms of the way that they believe business should be performed. Fourth, there is little or no consideration of the overall combinatorial complexity of the sum of the Orders. In other words, there is no systems-level analysis. This is one of the main causes of the systemic problem of overlap and redundancy.

In the organizations at the lower-level who implement an Order fully, the virtual image projected from the Order becomes real, with the implementing organization looking much like the Order writing organization. This in itself may not be a problem, but when there are over 140 virtual/real vertically isolated images instantiated in a contractor's organization that does cross-talk, this creates organizational and managerial confusion. On a note that is more relevant to QA professionals, when top management in the contractor organization responds to the oversight requirements of these Orders in terms of assessing organizations, they tend to create isolated assessment organizations that (to one degree or another) mirror the vertical isolation of the organizations that wrote the Orders.[15]

The bottom line of reading the 140 DOE Orders was that there was no ONE Order that described how to interrelate the other Orders and SEN's in a way that made sense. I performed an experiment. I ignored the specific content of the 10 criteria of DOE 5700.6C and began thinking about them as functional categories or boxes.[16] The key was to think about the 10 criteria as functions that were performed rather than

---

[14] I believe that Andy Mravca and the DOE-BAO staff were the first DOE Area Office to develop such a list and formally transmit it to their contractor.

[15] An example would be the issuance of DOE 5700.6C (Quality Assurance), DOE 5480.19 (Conduct of Operations), and the Secretary's July 31, 1990 memo on Self Assessment resulting in three distinct oversight or assessment functions.

[16] The 10 criteria are 1) program, 2) personnel training and qualification, 3) quality improvement, 4) documents and records, 5) work processes, 6) design, 7) procurement, 8) inspection and acceptance testing, 9) management assessment, and 10) independent assessment.

simply as requirements in a DOE Order. In other words, criterion 2 of DOE 5700.6C did not just list QA requirements for training and qualification, training was just something that was needed to operate any organization from a yogurt stand to a high-energy physics lab. I began to place all of the DOE Orders into one of these 10 functional categories based on the performance objective of the Order, i.e., its Purpose Statement. For example, I placed 1324.2 (Records Disposition) and 1324.5 (Records Management) under criterion 4 (Documents and Records). I placed 4330.4A (Maintenance Management Program), 1330.1C (Software Management), and 5480.19 (Conduct of Operations) under criterion 5 (Work Processes). I placed 5000.3A (Unusual Occurrence Reporting System) under criterion 3 (Quality Improvement). They all fit!

This approach evoked the image of the 10 criteria as an orchestra leader directing over 140 instruments or a facilitator running a large meeting. In other words, DOE 5700.6C orchestrates and integrates the management systems that are already required by other DOE Orders and SEN's.[17] On the one hand, DOE 5700.6C acts as the integrator, on the other hand it is simply one of over 140 other DOE Orders. Unless DOE 5700.6C is allowed to take on this dual role, one cannot talk about a total management system at DOE funded facilities because a DOE-based total management system *must be* defined within the parameters of the bureaucratic constraints of the DOE Order system.

Placing the Orders under one of the 10 criteria based on performance objectives is fine as long as you stop at the purpose statements. But if you actually begin *to read* the Orders for content, you realize that you have opened up Pandora's Box! Inside the box the problem manifests itself in two interrelated ways. First, there is the terminal fragmentation of over 140 Orders requiring (for example) 100 different types of training programs. Second, there are multiple Orders which claim to be "management" programs.[18] These problems are heuristics that point back to the problems described above, especially the tendency of DOE organizations to write their Orders in vertical isolation from each other. But this also points to a cure for this bureaucratic nightmare by using DOE 5700.6C as the harmonization framework needed for a total management system at the contractor level. The conceptual framework for doing this is found in the current revision of Appendix 12 of the Fermilab QAP where the laboratory Director assigns a responsible, implementing, and assessing organization to each DOE Order and SEN. In addition, all organizations that are designated as the responsible organization for a specific Order have completed an analysis of each Order that indicates which of the 10 functional criteria appear in that Order.

When the DOE Orders are viewed functionally, there are a number of Orders in which all 10 criteria are found. For example all 10 of the functional criteria of DOE 5700.6C are contained in the 18 elements of DOE Order 5480.19 (Conduct of Operations) although 15 of the elements are performance criteria (work processes). This should not be surprising for a document that is actually a fine-grained work process document. Another example is the 33 performance objectives of DOE 4330.4A (Maintenance Management Program), all of which fit under one of the 10 functional criteria of DOE 5700.6C. In fact, I claim that if you implement DOE Order 5700.6C in an organization that performs maintenance as a work process, you have implemented DOE 4330.4A. In other words, DOE 4330.4A *just is* DOE 5700.6C with a maintenance spin on the work processes and training requirements - almost all other aspects of the two

---

[17] The *DOE Office of Energy Research Implementation Plan for DOE 5700.6C Quality Assurance*, p 6 explicitly states that this can be one of the functions of DOE 5700.6C.

[18] For example one of the Orders that would "pretend" to be a total management system is DOE 5480.19 (Conduct of Operations).

documents are functionally identical. The redundancy discussed above is typified by DOE 4330.4A's injunction to implement a maintenance management program *and* a QA program when functionally, they are the very same thing.

Conclusion

In this paper, I tried to show how the cultural-paradigmatic *internal* beliefs and practices of HEP interact with the cultural-paradigmatic *external* beliefs and practices of DOE (many of which come from a nuclear or naval nuclear background) at the interface of managing DOE funded laboratories using the management systems prescribed in DOE Orders. I used this description of the broader sociological and cultural context to support the claim that developing a QA program based on the DOE-ER guidance and using DOE 5700.6C as an integrating function has enabled the laboratory to move toward a more realistic total management philosophy that tailors the implementation of DOE Orders and is ideologically compatible with the traditional scientific culture at Fermilab. In addition, this approach of using the 10 criteria of DOE 5700.6C as a functional integrator for the rest of the DOE Orders transforms quality assurance into a system for carrying out the performance objectives of the laboratory at the appropriate level - the mission specified in the M&O contract. It also focuses our attention at an overall systems level which is the only level at which the problems of redundancy and duplication in requirements can be addressed. This approach is the only way I know of to talk about a total management system within the DOE Orders system because it provides a way to make sense of the myriad DOE Orders. It will enable the DOE-ER sponsored facilities to move toward smart-thinking compliance not blind verbatim compliance. It will enable management at national laboratories to develop (scientific) culturally specific asymptotic management boundaries within which there is a "confined" freedom. It can help to channel the irreverence toward boundaries (so typical of creativity) toward puzzle solving within a paradigm/culture that includes tailored interpretations of DOE Orders. One closing note: if DOE continues to fund the types of research it currently funds, the changes described above will have to be integrated into the training of university graduate students, for only then will these aspects of the DOE culture really become a part of the culture/paradigm of science.[19]

---

[19] A major step in this direction was the (first time) offering of a series of courses called "Management at National Laboratories" for the 1992 US Particle Accelerator School that was recently held at SLAC. The courses were taught by W.K.H. Panofsky, James Coleman, William Wallenmeyer, and Wu-Tsung Weng and could be taken for credit through the Applied Physics Department (Physics 493F) at Stanford University.