AC 2008-2849: A TAXONOMY OF EPP PROBLEMS

Peter Boerger, Engineering Economic Associates, LLC

Peter Boerger is an independent consultant specializing in solving problems that incorporate both technological and economic aspects. He has worked and published for over 20 years on the interface between engineering, economics and public policy. His education began with an undergraduate degree in Mechanical Engineering from the University of Wisconsin-Madison, adding a Master of Science degree in a program of Technology and Public Policy from Purdue University and a Ph.D. in Engineering Economics from the School of Industrial Engineering at Purdue University. His firm, Engineering Economic Associates, is located in Indianapolis, IN.

A Taxonomy of 'Engineering and Public Policy' Problems

1. Introduction

The field of Engineering and Public Policy (EPP) is necessarily an interdisciplinary field, residing on the boundary between academic disciplines. This position presents both opportunities and challenges. Those who are sojourners in a field have the opportunity to see its problems through a different lense, sometimes leading to new and creative solutions (see e.g. Dogan and Pahre[1]). On the downside, these fields run the risk of being seen as outsiders by the fields they are trying to integrate.

Additionally, people might ask why these problems cannot reasonably be addressed within more traditional disciplines (i.e. standard engineering departments or schools of public policy), leading to some difficulty in starting and maintaining these operations. In such a situation, it is important to clearly define the field's domain and why it is that the problems in your domain cannot be solved very well without its existence.

To address that situation, this paper attempts to develop a useful taxonomy of the types of problems legitimately within the field of EPP and, perhaps more importantly, the problems that fall outside.

2. Why a "taxonomy?"

The dictionary presents the word "taxonomy" as a term primarily from biology meaning " . . .the branch of science concerned with classification . . .". With the goal of this paper being a "taxonomy" of EPP problems, the task of this paper is then a classification of those problems.

One may ask why the need to classify problems? After all, classification takes effort and potentially leads to conflict about the correct hierarchy of the classification. Why not just take problems as they come without thinking about "where they go."

It is precisely because of those potential conflicts that classification is useful. By classifying problems we can discuss up front which problems are reasonably addressed in one field vs. another, hopefully replacing unstated discomfort with the place of addressing certain problems with an argued and resolved state of peace on that subject.

Many times, creating a classification can also lead to new avenues of inquiry by providing ideas for application of tools and techniques from other problems in the same class.

3. The difficulty of classification

The main problem of the taxonomy is the hierarchy. At the top of the taxonomy should the distinction be between animals that live on land vs. water or is it mammals vs. non-mammals or is it presence of a backbone vs. invertebrate? Any of these hierarchies will "work" in the sense

of leading to a taxonomy. It seems that what makes one system "better" than another is simply the purpose to which is it put and how well it serves that end.[2]

Hence, for example, biology has developed a field called "cladism," the type of taxonomy based on evolution vs. physical characteristics of organisms. If the purpose of a particular taxonomy is to help understand and analyze evolution, then the use of a "cladistic" taxonomy is best. For some other purpose another type of taxonomy might better suit.

Similary in this paper, the hierarchy of the taxonomy is chosen based on what the author thinks best addresses the problem at hand: justifying the existence of distinct EPP programs separate from "standard" engineering disciplines and helping to think through tools that may be useful in such a "border" field. Readers may have other opinions as to the most useful hierarchy. It is hoped this paper will be the beginning of such a discussion rather than being the final word.

We now begin a look at the suggested taxonomy itself.

4. The top level of the taxonomy: the problem

At the top of a biological taxonomy is the question: "Is it an organism?" Anything that is not an "organism" is excluded from further consideration in the taxonomy. EPP also has a "top level" question to be answered. It is proposed here that the top level question is "Is it a problem?"

Engineering takes on the task of applying science to the solving of problems. If there is no problem to be solved, then we are merely describing something—the job of science. Descriptions and developing an understanding of "nature" (broadly defined) is a worthwhile undertaking, and engineers need a thorough scientific understanding in order to solve problems, but if there is no problem to be solved, then it is not engineering.

Similarly, public policy is necessarily a problem solving field. Any public matter over which there is no cause for concern will not come to the attention of public decisionmakers/opinionmakers and should not. The limited resources available for analysis should only be applied to matters that need attention.

Thus, "the problem" represents the top level in our taxonomy.

5. The second level: technological problems vs. those not involving technology

The main feature that differentiates EPP programs from standard public policy programs is the element of technology. Not that 'standard' public policy programs cannot and do not sometimes deal effectively with technologically rich public policy problems or that EPP programs will never be called on to consider non-technologically-related matters, rather that EPP programs are best situated to deal with these kinds of problems.

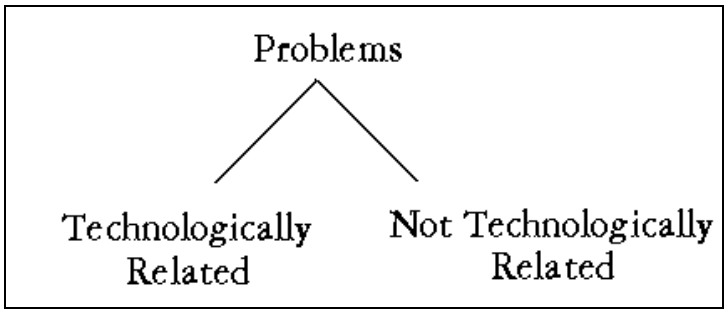

Figure 1. Levels 1 and 2 of the taxonomy: problems that are and are not technologically related.

6. The third level: public vs. nonpublic problems

In looking at problems to be solved, the first categorization that we most usefully make (it should come as little surprise) is between public vs. private problems. "Public" problems are those over which there is a significant amount of public interest whether or not they are solved. This category includes the "public goods" from economics (e.g. education, national defense, environmental quality). "Private" problems are all the other problems we deal with in life, such as the creating of new product designs, the manufacture of products, the growing and harvesting of food, etc.

As with all classifications, there will not always be a clear line between public and private. For example, 'feeding one's family' would probably receive agreement as primarily a "private" problem, but 'ensuring that no one in society goes hungry' is usually seen as a "public" problem. While people may disagree as to exactly where the dividing line between those problems lies, a society must make such divisions. The mere fact that we have a field called "public policy" implies that there are matters that lie outside of the public sphere, and making that distinction, while not always easy, is necessary and is in fact done.

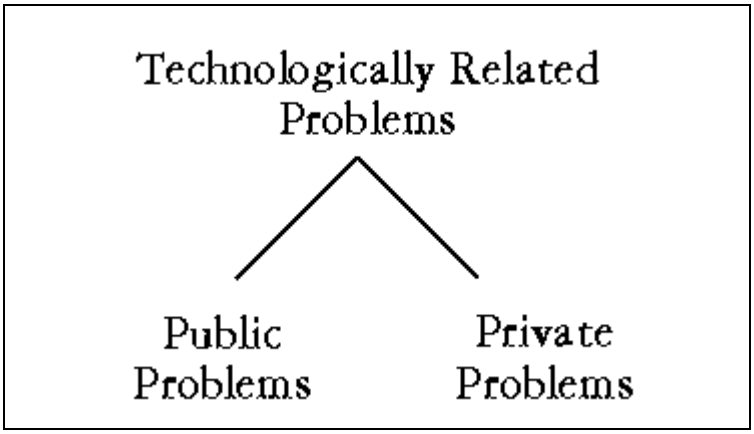

Figure 2. Level 3 of the taxonomy: public vs. private technologically related problems.

7. The fourth level: two kinds of public problems

Some might think that all "public" problems having an engineering component are the domain of engineering. But upon reflection, it should be evident that not all public problems are candidates for inclusion in the class of EPP problems. For instance, the design of a sewer system for a city is a public problem, but it is not an EPP problem. That problem can be solved entirely within the field of civil engineering. Just as the design of a new jet fighter is a problem within the public sphere, but it can be solved entirely within the field of aeronautical engineering. There must be another aspect to what defines an "EPP problem" other than whether it is a "public" problem.

I propose here that the factor which separates an EPP problem from a "public engineering" problem is whether the object of the problem solving most directly involves "people" or "things." While the building of a new bridge may serve the public interest, its design and building involves the virtual and physical manipulation of inanimate objects. As such the design of a bridge is an engineering problem, not an EPP problem.

While this may be easy to see with a bridge, it may not be so clear in other areas. The use of renewable resources to generate electricity is a matter of great interest in public policy circles. The amount of electricity society should require be generated from renewable sources, however, is a matter of public policy, and answering that question certainly requires an understanding of the state of our ability to tap those resources. But the design of new or improved renewable resources is not a public policy problem; it is an engineering problem.

Scholars in an EPP program may be capable of improving the design of renewable energy systems, and they may in fact take on that kind of job from time to time (for reasons of personal interest or for reasons of needing to "pay the bills") but that work is not part of EPP. Rather, it is solving an 'engineering' problem in a field that currently receives a lot of 'public policy' attention.

This discussion may clarify a subtle point: that EPP, contrary to the presence of the word "engineering" in the title, does not deal with engineering problems. EPP actually deals with non-engineering problems. The primary role of EPP is to support the overall solution of public policy problems. Thus the sole reason for existence of EPP programs is the need for technical understanding in approaching (not necessarily technical) public policy problems.

Now the more technically related the public policy field, the more likely that EPP will be able to contribute usefully. But "public policy" necessarily implies that the matters of interest are people, not things. And anywhere that technology potentially affects people or arises as part of a possible solution to a problem directly affecting people is the legitimate domain of EPP.

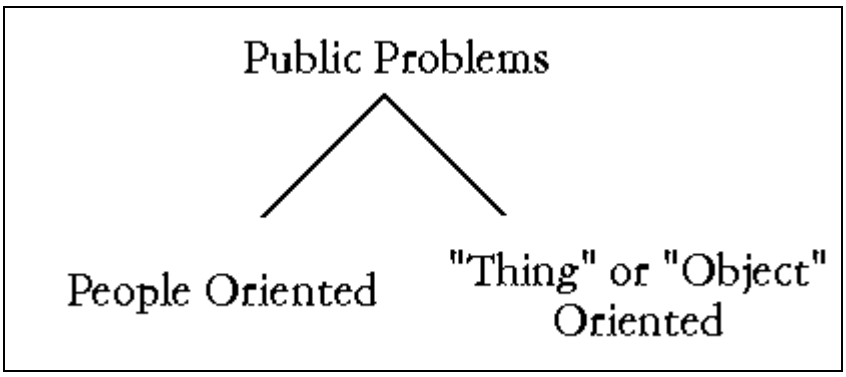

Figure 3. Level 4 of the taxonomy: technological public problems that are people vs. "thing" or "object" oriented.

8. The fourth level (again): two kinds of private problems

One might think that EPP would have nothing to do with "private" problems, and solely looking at the name of the field that thought seems reasonable. However, there is an aspect of "private" problems that seems worthy of thinking through as a potential EPP category.

To get at that aspect, we need to think about the "outcomes" of engineering work on private problems. While the subject and intent of a body of engineering work may be "private" in nature, the result may have public implications. Those "public implications" we will call here "unintended consequences." Thus the category of "private" problems is divided into categories of those resulting with "intended consequences" vs. "unintended consequences,"

"Progress" has us (the people of the world) hurtling forward in our understanding of the world, solving problems (creating opportunities), and the pressure on scientists and engineers in our society is to be first to solve problems. Doing so allows enterprises to take advantage of market opportunities--to be the first to develop products making use of new scientific knowledge. A recent article in the Economist magazine on nanoparticles (as one example) makes the point that these new materials are being used more widely (and available via first class mail with a credit card) without a strong understanding of their potential risks.[3]

By highlighting the category of unintended consequences, I am not suggesting that engineers do not think about the possible ramifications of their work. Many do, and I am sure that many problems of potential "unintended consequences" are caught before an engineering solution is ever implemented.

However, by definition, identifying and dealing with "unintended consequences" are never the primary aim of an engineering effort, and shouldn't be. Engineering efforts are only undertaken in response to some problem (opportunity). If an engineer were not to devote primary attention to solving the problem of interest, the risk of failure would rise substantially.

There is nothing wrong with, and a lot to be said for, that 'blindered' kind of focus. And while engineers themselves can, should and do think about unintended consequences as they work on solving a problem, it seems like an important focus for EPP programs to orient themselves to think about these consequences; perhaps to think about approaches and tools to help society understand and address unintended consequences more quickly.

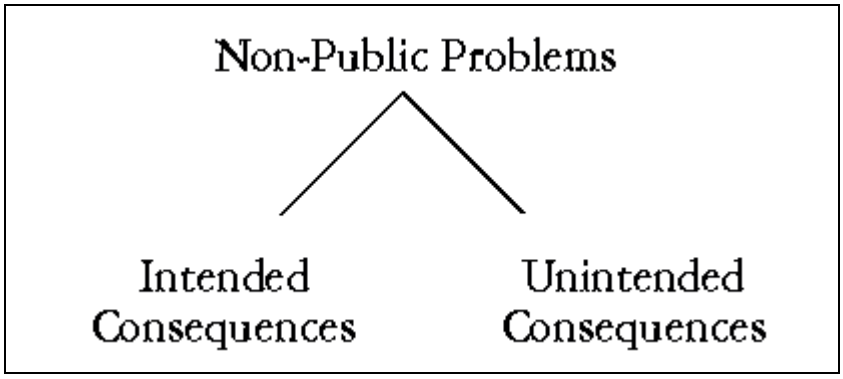

Figure 4. Level 4 of the taxonomy: technological, non-public problems with intended Vs. unintended consequences.

10. Summary and Conclusions

Figure 5 shows the taxonomy that has been developed in this paper. The bottom row shows the two areas this paper has suggested as the most appropriate areas for EPP concentration: 1) technologically related, public problems that are people oriented and 2) the unintended consequences of technologically related, private problems.

There are clearly other categories that the work of EPP programs can be thought to fall into, for instance 'communicating' the technological aspects of public policy problems vs. 'solving' them. Perhaps others can add further levels or think through alternative approaches to the taxonomy.

In establishing the importance of an EPP program to a university, it is important, I think, to ask the following two questions: 1) 'what are the kind of problems (with concrete examples) that require an engineering understanding, but that an engineering department can not solve' (at least not without 'stretching') and 2) 'what are the kind of problems (with concrete examples) that a school of public policy could not solve (very well) without an engineering understanding'. With that list in hand, the legitimacy and demarcation of the EPP program is established.

It is hoped that this paper will serve as a useful starting point for generating such 'sets' of problems. Once established, further discussion as to the curriculum best suited to solving those problems might be a topic for further thought.

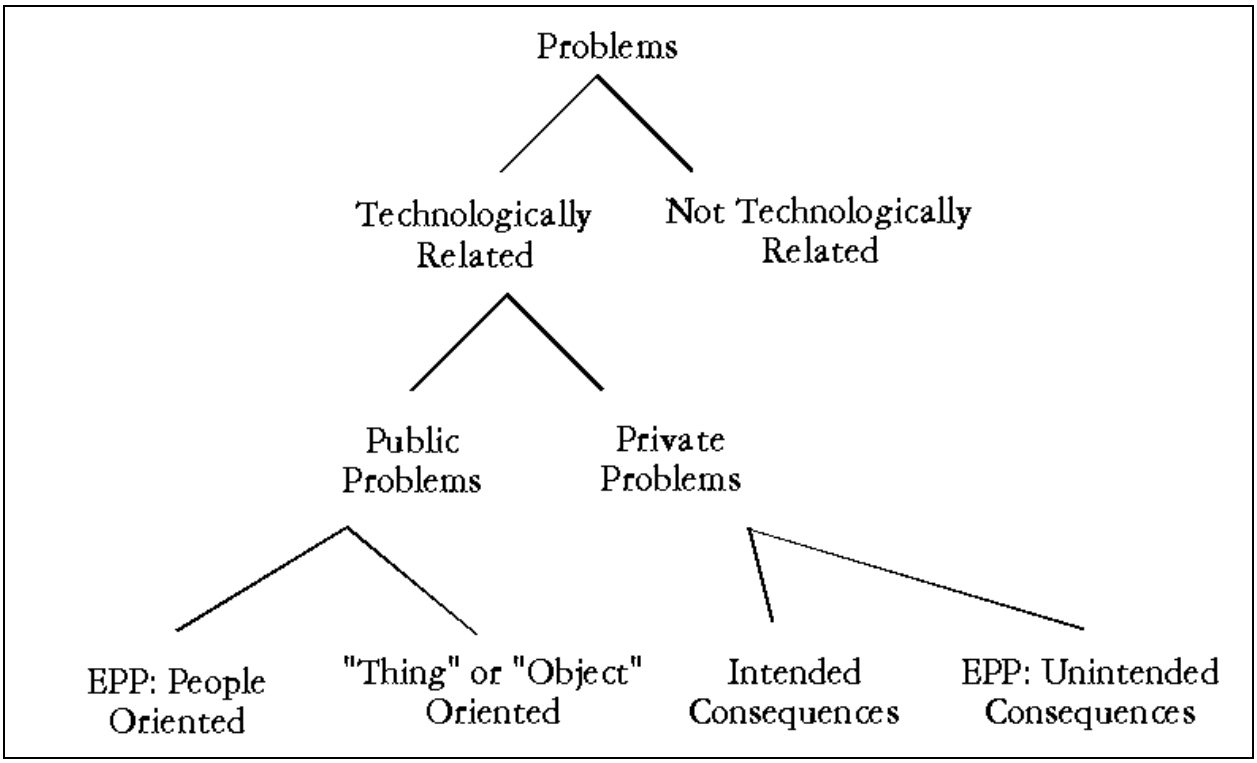

Figure 5. The Completed Taxonomy.

References

1. Dogan, M. and R. Pahre. *Creative Marginality: Innovation at the Intersection of Social Sciences*. Boulder: Westview Press, 1990.

2. For a discussion of the difficulties of biological classification see: Ruse, Michael. *Philosophy of Biology Today*. Albany: State University of New York, 1988.

3. "A little risky business." *The Economist* 24 November 2007: 385.