121st ASEE Annual Conference & Exposition
Indianapolis, IN
June 15-18, 2014
Paper ID #10812

Students Pursuing Senior Projects Analyze the Public Need and Draft the Public Policy

Dr. Murray Teitell, DeVry University, Long Beach

Murray Teitell is a Professor at DeVry University, Long Beach, California. He teaches courses in mathematics, science and technology. His research interests are algorithms, solutions of equations and statistics as they relate to education, engineering and design.

Mr. William S. Sullivan, DeVry University, Long Beach

Students Pursuing Senior Projects Analyze Need and Draft Public Policy

Abstract

Engineering and technology students undertake a senior project in the final year of their degree program. One common requirement in the proposal phase of the senior project is that the student team demonstrates a public need for the unique service or product that would result from the project. This need is identified through research in the literature and utilizing observations and surveys. The authors introduced assignments in their senior project courses for students to address the impact of the project on public policy. Many devices developed for senior projects have public polices associated with them, both regulatory and distributive. Engineers and technologists do not usually receive training to be policy makers. These assignments gave them the students the opportunity to develop, understand, and incorporate public policy in device development for senior projects.

Introduction

Public policies support and propel new products and services. They can also hinder their adoption.[1] Students in senior projects propose new products or services. In developing the project concept, senior project teams research individual needs and determine the market. Anchoring the product to a verified societal need is part of the process of making new products and services. Societal needs lead to public policy creation. In creating new products and services, a company may lobby for public policies that help and further their products(s). It is important that students learn about the role public policy plays in creating successful products and services.

In their senior project courses, the authors assigned students to consider individual and societal needs and public policies as part of the proposal phase of senior project. The students authored public policies intended to protect the individual and societal needs and promote their product or service. The approach the students followed was the identification of individual and societal needs with a connection to public policy.[2-3] Some employers are requiring that engineers be more socially responsible in their practice.[4] The teaching of ethics is part of many engineering curriculums.[5]

The following individual needs were identified to the students as those to be fulfilled by their senior projects.

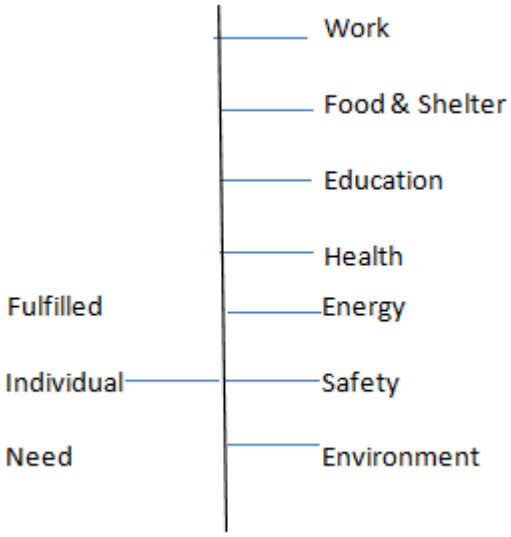

Figure 1: Individual Needs

The following societal needs were identified to the students as those to be fulfilled by their senior projects.

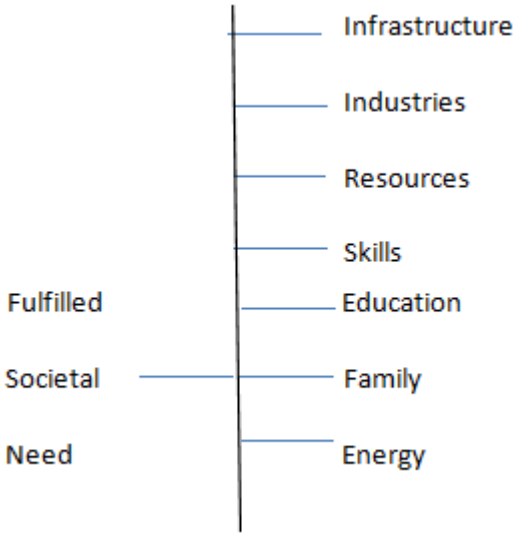

Figure 2: Societal Needs

The following categories of public policies were projected by the students on their senior projects from the individual and societal needs.

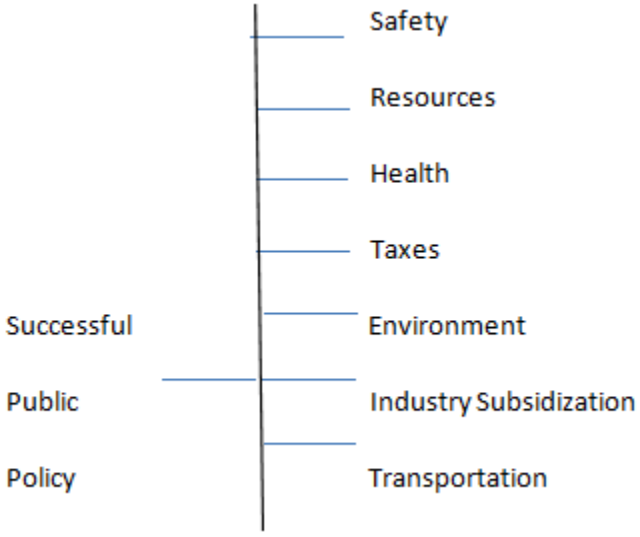

Figure 3: Public Policy

The students measured individual needs and societal needs utilizing established metrics. The students researched public policies and laws related to the individual needs and societal needs. The information gathered was utilized to determine public policies that further the product.

Table 1: Metrics

Metrics	Normalized Score
1 - Eventual product helps society	1 or 0
2- There is a public need for the product	1 or 0

Metrics measure quantity and/or quality.[6-9] Metrics measure actual performance or projected performance. Thusly, metrics evaluate and compare outcomes such as alternate public policies.

To evaluate the public policies[10] and choose the best ones, the authors derived an evaluation system of the metrics. Student teams were given a spreadsheet template for the metrics. They were encouraged to modify the metrics as appropriate for their concepts. Each metric included a fuzzy-weighting factor which imposed an increasing or decreasing emphasis on that particular metric.[11] The same metrics were applied to all the senior project concepts.

Societal compatibility is a metric that measures contribution. A project and product is most useful if it contributes to the welfare of society. This metric measures the quantity (the number of ways the potential project is to help society) and quality (by rating the public identification with the potential product). Improving the quality of life is part of the social compatibility metric.

The individual needs metric counts the number of pronounced needs to be fulfilled and the quality rates the competition for these needs and the uniqueness of the potential product. This metric further characterizes the potential market share.[12]

Results

Students were provided the metrics to incorporate in their senior project concepts. Metrics were scored by multiple sources according to a template. The scorers followed the template and estimated the scores following the protocol. The students calculated a metric data set for each senior project concept.[13] This allowed for comparison and selection of the best public policy.

Table 2: Multiple Sources of Measurements

Measure	Source	Method	Type
Fixed Metrics	Team Members	Scoring Template	Estimate
Fixed Metrics	Professor(s)	Scoring Template	Estimate
Fixed Metrics	Peers	Scoring Template	Estimate
Fixed Metrics	External Sources	Scoring Template	Estimate

Metric Value Computation

Societal Need metric (So) = 1 or 0 as described in protocol

Scoring Procedure: The project team has a mission statement which lists all the goals and interests of the team, its members and the project. Assign a number of 1-10 for each goal and interest and its compatibility with helping society, identifying with the project and improving human life. Add all the compatibility numbers and divide by the number of interests compatible to get the average society score. If > 7, assign 1 otherwise assign 0.

Individual Need metric (P) = 1 0r 0 as described in protocol

Scoring Procedure: The team has a needs statement which lists all the individual needs fulfilled by the project and the potential product. Assign a number of 1-10 for each need fulfilled. Need fulfillment takes into account whether or not the need is already fulfilled or the extent that there is competition (market share) and the probability that it can be manufactured successfully and the probability that it can comply with all regulations and safety and ethical concerns. Add all the need numbers and divide by the number of needs to get the average individual need score. If >7, assign 1 otherwise assign 0.

Examples of the metric scoring and the projection of public policies is shown below in tables 3-5. The examples are for three student senior projects in the authors' classes. Table 1 shows the metric scoring for the individual and societal needs for a senior project of a three wheel electric bike. Table 2 shows the identified individual and societal needs and the projected public policies for a senior project of an automated pollinator. The purpose of the automated pollinator is to mechanically replace the role of the bee in pollination. Table 3

shows the identified individual and societal needs and the projected public policies for a senior project of a Friendly Fire Identification System (FFIS). The purpose of the Friendly Fire Identification System is to read an encrypted signal from a passive device (to be worn by friendly servicemen).

Templates to Score Metrics

Table 3: Metrics: Individual and Societal for Senior Project, Three Wheel Electric Bike Individual

Individual Need	Metric Score (1-10)	Societal Need	Metric Score (1-10)
Environmental Compatibility	8	Environment	10
Economically Sound	7	Economics	10
Dependable	5	Safety	7
Rugged	5	Convenience	7
Safety	5		
Features	5		
Transportation Ease	5		
———————————	————	———	————
Total	40		34
Average	5.7		8.5
Protocol	Does Not Meet		Meets
Metric Normalized Score	0		1

Table 4: Projected Public Policies from Individual and Societal Needs

Senior Project: Automated Pollinator (AP)

Individual Needs	**Societal Needs**	**Public Policy**
Pollination of crops	Food supply	Testing of automated pollinator
Food	Safety of food supply	Requirements of AP
Back-up for loss of bees	Safety of insecticides	Safety of AP
Reasonable price of food	Balanced diet	Subsidy for AP development
Availability of food	Safety of AP	Co-existence of AP and bees
Freshness of food	Viability of farming	Indemnify AP developer
Protection from health hazards	Reasonable prices of food	Certification of AP product
Protection from insecticides	Availability of food	Government contracts for AP
Balanced diet	Transportation of food	Incentive to farmer to test AP
Healthy diet	Protection Hazardous insect	Test bed for AP
Protection from hazardous insects	Viability of crops	Priority crops for AP

Table 5: Projected Public Policies from Individual and Societal Needs

Senior Project: Friendly Fire Identification System (FFIS)

Individual Needs	**Societal Needs**	**Public Policy**
Protection of troops and law enforcement from accidental wounding and death	Protection of troops	Funds for development FFIS in armed forces and police agencies
Confidence of troops	Well-trained armed forces	Requirements of FFIS
Less hazards for troops	Well-equipped armed forces	Safety of FFIS
Dependability of weapons	Prevention of terrorism	Subsidy for FFIS development
Prevention of accidental shootings	Ability to handle terrorists	Provisions to test FFIS in the field
More advanced equipment for troops	Ability to respond to armed aggression	Indemnify FFIS developer
Confidence of the public in armed forces and police agencies	High morale of armed forces	Certification of FFIS product
Protection from terrorism	Prevention of unnecessary causalities	Government contracts for FFIS
Equipment and weapons are easy to operate	Prevention of wounding and death of innocent bystanders	Competitions with prizes for FFIS systems
Excellent training programs for equipment and weapons	Safer weapons	Test bed for FFIS
Dependable and rugged equipment and weapons	Safety of FFIS	Laws requiring use of FFIS

Conclusions

Students used these statistical methods to select the public policy that supported their senior project and the products and services. Engineers and technologists are not educated or trained to consider or incorporate public policy in their services or products. The addition of metrics designed to integrate public policy consideration in senior projects allows students to develop an understanding of public policy. Taking the public policies into account allows student engineers and technologists to make better selections of the best designs in terms of performance, cost, and return on investment for new product situations in their future careers.[14-15]

References

1. Smith Kevin B. and Larimer, Christopher W. (2009). *The Public Policy Theory Primer*. Philadelphia: Westview Press.
2. Halimahtun, M. K. (2006). Embracing diversity in user needs for affective design. *Applied Ergonomics*, *37*(4), 409-418. http://dx.doi.org/10.1016/ j.apergo.2006.04.005
3. Mihelcic, J. R., Crittenden, J. C., Small, M. J., Shonnard, D. R., Zhang, Q., Chen, H., . . . Schnoor, J. L. (2003). Sustainability science and engineering: the emergence of a new metadiscipline. *Environ. Sci Technol.*, *37*(23), 5314-5324. http://dx.doi.org/10.1021/es034605h
4. Beder, S. (1999). Beyond technicalities: expanding engineering thinking. *J. Prof Issues Eng. Educ.*, *125*(1), 12-18.
5. Herkert, J. R. (2005). Ways of thinking about and teaching ethical problem solving: microethics and macroethics in engineering. *Science and Engineering Ethics*, 373-385. http://dx.doi.org/10.1007/s11948-005-0006-3
6. Eusgeld, I., Freiling, F.C., and Reussner, R. (1998*).Dependability Metrics (Advanced Lectures).* New York. Springer.
7. Klubeck, Martin. (2011*).Metrics: How to Improve Key Business Results.* New York. Apress.
8. Simpson, T.W., Poplinski, P.N., Koch, P. N. and Allen, J. K. (2001. Metamodels for Computer-based Engineering Design Survey and Recommendations. *Engineering with Computers. 17 (2) 129-150.*
9. Ebert, C., Dumke, R., Bundschuh, M. and Schmietendorf, A. (1998). *Best Practices in Software Measurement (How to use Metrics to Improve Project and Process Performance)*. New York. Springer.
10. Haas, Peter, J. and Springer, J. Fred (1997). *Policy, Research and Public Decisions: Concepts and Cases for Public Demonstration.* New York: Garland.
11. Vanegas, L. V. and Labib A.W.(2010). Application of New Fuzzy-Weighted Average (NFWA) Method to Engineering Design Evaluation. *International Journal of Production Research. 39(6) 1147-1162.*
12. Milosevic, D. and Patanakui, P. (2006) Standardized Project Management May Increase Development Projects Success. *International Journal of Project Management.23 (3) 181192.*

13. Messac, A. and Mattson, C. A. (2002). Generating Well-Distributed Sets of Pareto Points for Engineering Design Using Physical Programming. *Optimization and Engineering. 3 (4) 431-450*.
14. Bonser, Charles F., McGregor, Eugene B. Jr., Oster, Clinto V. Jr. (1995). Choices and Public Action, Englewood Cliffs, NJ: Prentice-Hall.
15. Fischer, Frank (1995). *Evaluating Public Policy*. Chicago: Nelson-Hall.