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Technology Delivery Systems - TDS

You can't manage what you can't model

I was first introduced to the concept of Technology Delivery Systems (TDS) by Dr. Ed Wenk, Jr. (Emeritus Professor U. of Washington). During one of our discussions, I complained to Ed about our inability to get major things done that were needed by the public and the environment. Many good engineering developments were not translated to action and progress in the real world. And, many apparently engineering developments turned into 'bad ideas' that resulted in accidents, failures, and major losses in the quality of life.

Ed responded "you can't manage what you can't model." He described the model of a TDS that had come from his experience of more than 50 years with development of an extremely wide variety of engineered systems. As he described the TDS, it had three primary components (Figure 1). The first was the public (societies) that was concerned with and would be impacted by the technology. The second was government at all levels representing the interests of the public; government of, for, and by the people. The third was commerce and industry that provided the 'engine' for implementation of the technology; the technological enterprise. These three components had a wide variety of linkages and interactions and were dramatically influenced by values, beliefs, knowledge, preferences, and available resources. Cultures deeply rooted in history were of extreme importance.

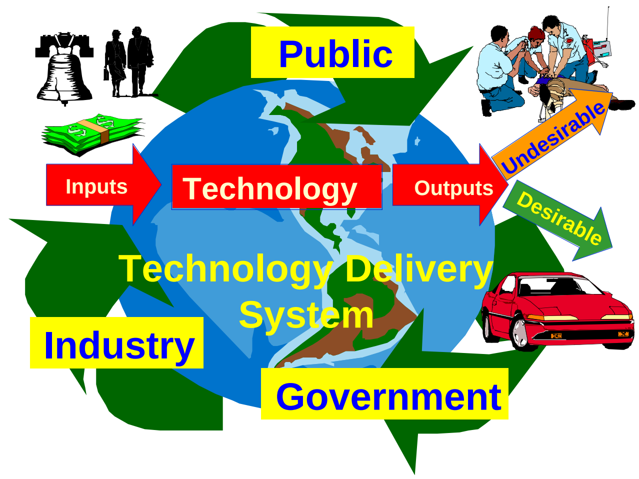

Figure 1 - Technology Delivery System

Ed's description of technology turned out to be different than I expected. He described technology as a social process by which specialized knowledge from sciences and empirical experience is employed through engineering to deliver a system to meet specific human needs and wants. He described engineering as artful combination of backgrounds and knowledge from physical, natural, and social sciences to develop useful contrivances. These broad definitions posed some real challenges for traditional engineers because as Ed put it "engineers want to believe that the planet is not inhabited." While engineers frequently produced artful contrivances that benefited civilization - the intended consequences of their efforts - sometimes, because of engineering ignorance or neglect of social and natural sciences the contrivances produced dramatic and severe unintended undesirable consequences.

I formulated each of the three components in terms of 'transfer function' processes consisting of inputs, outputs, goals and objectives, and artifacts, resources, and processes (Figure 2).

Then I proceeded to examine each of the three components of the TDS in these terms. The first was the Society (public) component (Figure 3). I formulated the goals and objectives as Life, Liberty, and the Pursuit of Happiness (LLH) and to sustain (protect, maintain) the society (self, family, friends, groups, and beyond). Artifacts, resources, and processes are essentially reflected in a nation's peoples, knowledge, rules, skills, beliefs, behaviors, abilities, and by-products; often termed the culture, tools, and products of a people that live in a region or regions identified as a nation. I identified two categories of inputs: National and International.

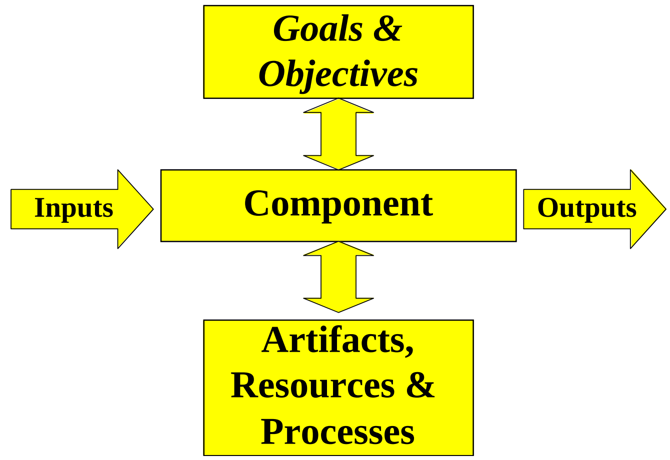

Figure 2. A TDS Transfer Function

Next was the Government component (Figure 4). In this case the goal and objective was the protection of LLH and to sustain (preserve, maintain) government. In this component, I identified the artifacts, resources, and processes attributed to 'engineering.' Engineering can and does play a major role in government; frequently demonstrated in the engineering influences (or lack thereof) in legislation, regulations, law, and education. Engineering also can and does show up in management and leadership. The knowledge, skill, rules, and capability ('fluffyware' and 'software') resources provided by engineering are of vital importance in creation of today's engineered systems.

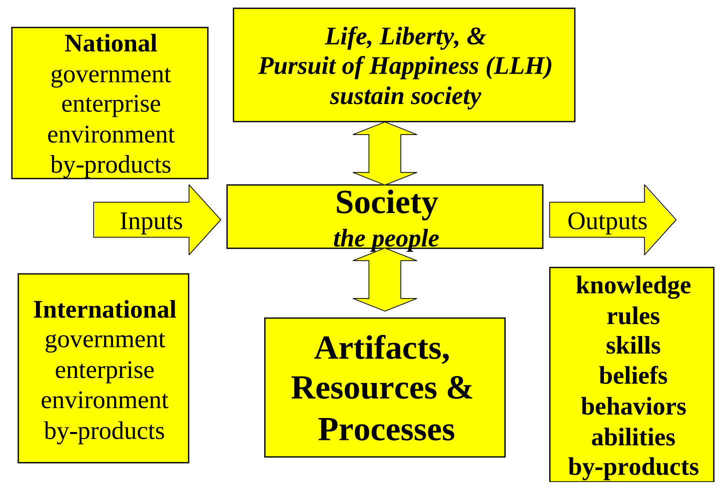

Figure 3. The Societal Transfer Function

Next was the Enterprise (commerce - indusrtry) component (Figure 5). Enterprise can be carried out in either or both the industrial (often called private) and governmental (often called public) sectors or components. In this case the goal and objective was the production of goods and services for LLH and to sustain (preserve, maintain) enterprise; this last element must include 'profitability' - without profitability, there can be no business - enterprise component. In fact, this element must be present in all three components. In this component, I identified the artifacts, resources, and processes attributed to 'engineering.' Engineering can and does play a major role in enterprise; frequently demonstrated in the engineering influences (or lack thereof) in tools and techniques, artifacts, resources, and processes used in the enterprise. Other vital resources include management, leadership, capital, human and other natural (or un-natural) resources.

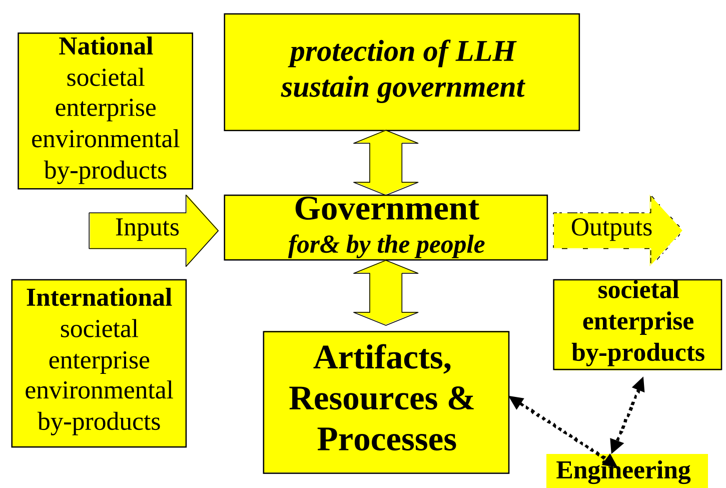

Figure 4. The Government Transfer Function

My next steps were to identify in the Enterprise and Government components where and how engineering could impact the TDS (Figures 6 and 7). I cast the outputs in terms of Quality and Reliability (Q&R). Q consists of serviceability (fitness for purpose), safety (freedom from undue exposure to harm and injury), compatibility (meets specified goals and objectives), and durability (sustainable, freedom from unexpected degradation in performance). R is the likelihood that Q will be developed throughout the life-cycle of the engineered system. The likelihood elements in R address four categories or types of uncertainties: natural and modeling (intrinsic) and human - organizational and knowledge - information (extrinsic). The life cycle includes concept development, design, construction or manufacture, operation, maintenance, and finally, decommissioning. The engineered system is comprised of seven interactive, interdependent, adaptive (changing in response to stimuli) including human operators, organizations, hardware, structures, procedures, environments and interfaces among the foregoing.

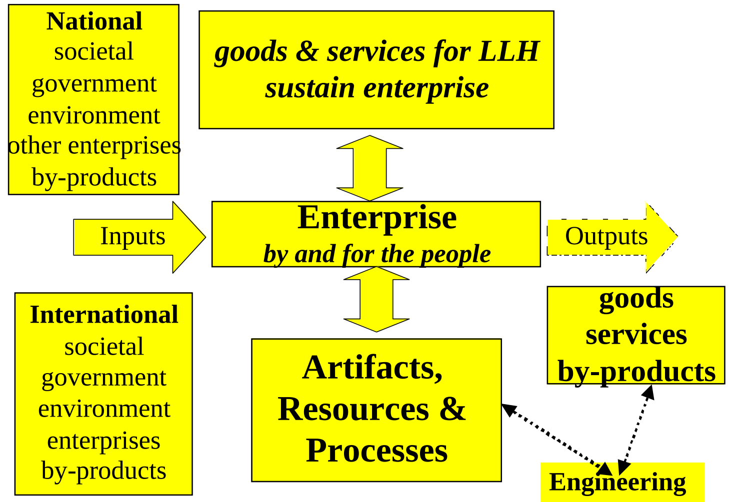

Figure 5. The Enterprise Transfer Function

I identified two primary goals and objectives for the two components: maximize beneficial effects and minimize harmful - undesirable - effects. In one case we want to maximize desirable Quality (Serviceability, Safety, Compatibility, Durability) and Reliability (likelihood of realizing desirable and acceptable Quality). In the other case we want to minimize the potential negative elements of Quality and lack of desirable and acceptable reliability. Issues of sustainability and environmental compatibility have proven to be of critical importance.

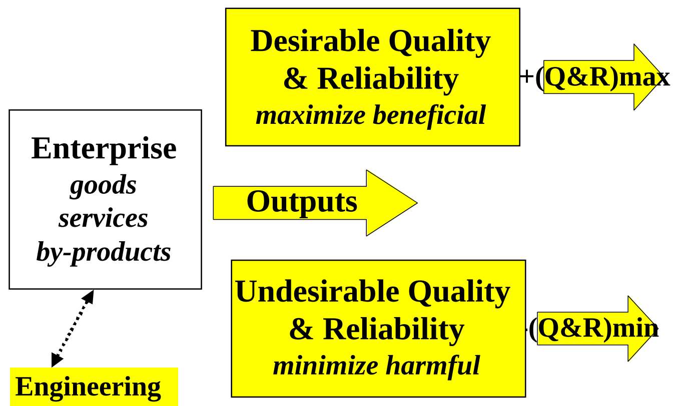

Figure 6. Engineering Goals and Objectives in Enterprise

It has been proved to be very important to make the connections between these components to determine how engineering can be more effective in its efforts to help develop engineered systems that have desirable quality and reliability for the nations, societies, governments, enterprises that are served. Without these connections, there can not be an effective engineering TDS.

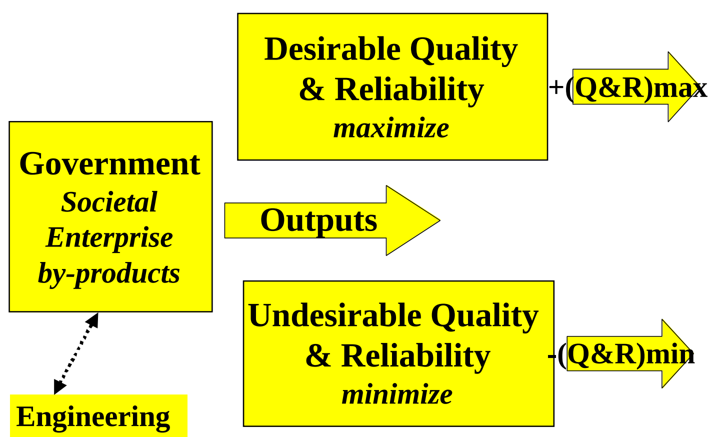

Figure 7. Engineering Goals and Objectives in Government

The critical element of making the connections is communications. It is here that I learned from Ed about the 'power of the press' and media to get information to the public, government, and commerce - industry. One needed to be choosy - selecting the media sources and outlets that would develop useful insights and information for people; no 10 second sound bites. The media sources needed to demonstrate scholarship, honesty, and quality in their communications. Creation and maintenance of public trust was essential.

I also learned the importance of providing information in appropriate ways and appropriate times to 'decision makers'. This meant that I had to leave the comfort of my office and go to meet with representatives of all of the components; the public, the government, and commerce - industry. The theme of the communications was to tell what I had learned that could help them make better decisions and to help build consensus; united we succeed; divided we fail. Informed and properly motivated deliberation and debate needed to be encouraged. There were several important instruments in development of communications; the institutions of government, faith - belief based institutions which encapsulated a wide variety of value-oriented doctrines, and public institutions - groups which represented collations of the concerned and affected people. Ed contended that the message content of the communications needed to shaped and steered by three 'operating instructions'; the engine of the free market place, public policy, and values embedded in the cultures that ignite moral vision and mold conduct.

Ed concluded my education with a summary of 12 axioms that summarized his experiences with TDS:

1. Technology empowers all life support systems---food production, transportation, communications, military security, shelter, urban infrastructure, health affairs, environmental management, energy production, banking, criminal justice, education, entertainment, even religious institutions.
2. While manifest as hardware--planes, trains and automobiles--technology is best understood as just described, as a purposeful arrangement of public and private organizations synchronized by information networks.
3. Most hardware is conceived, designed, produced, and marketed by private enterprise in a capitalist industrial economy under a mantra of "efficiency."
4. All technologies spawn surprise side effects, most unwanted by some sector now or in the future..
5. All technologies pose risks from accidents triggered by human or organizational error with unprecedented scale and geographical distribution. .Accident prevention must thus be integrated with engineering design.
6. Technology generates wealth and enhances living standards, but it also fosters materialism, concentrates rewards, and increases appetites for both..
7. Major decisions about technology are not made by scientists, engineers or business executives. The most salient are in the design of public policies. Technology thus tends to concentrate political power, just as power tends to concentrate technologies as corporate structures.
8. We enjoy what technology does *for* us, ignoring what it can do *to* us. One counter trend is shifting from "Can we do it?" to "Ought we do it?" and "Can we afford it?"
9. These cultural impacts appear as paradoxes: more communications but less sense of community, more information but less understanding, more machines for living but less leisure. Technology distorts perceptions of time and tends to focus on the short run at the expense of longer term costs and benefits. It also distorts perceptions of space because the entire planet is wired,
10. Technology tends to weaken human relationships and to foster self-indulgence and isolation.
11. In an age glorifying information, we neglect its transformation into knowledge and then into understanding. These steps require time for cogitation and for preparing the mind.
12. Despite its material benefits, technology induces anxieties and stress because the pace of change seems to exceed natural human rhythms, and because of greater complexity, multiple information feedback loops, and uncertainties about the future.

I hope you will find this TDS model useful. Thank you Ed Wenk.

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