Comments On

Science Team Leadership

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Given the time constraints of the workshop on team leadership and team dynamics

I will confine my remarks to Professor Day's analysis of Team Types:

- **Action**: perform important, interdependent, and highly consequential tasks
  - Extreme action (Trauma; SWAT; Special Forces)
  - Manufacturing or production (Self-managed)

- **Innovation**: introduce and implement new ideas, processes, or procedures
  - R&D functions

- **Science Discovery**: creation, discovery, and dissemination of new knowledge

- **Multiteam Systems**: teams of teams to accomplish ambitious goals too large for a single teams

The following discussion is based upon Professor Day's paper and his summary of

his paper presented as part of conference call on June 20 2013.

I was asked to participate in this workshop because of my directorship for 16 years of the Institute of Energy Conversion (IEC), a Department of Energy Center of Excellence in Photovoltaic Research and Education at the University of Delaware. There were only two such centers in the United States. IEC is a laboratory devoted to research in thin-film photovoltaics and as such interacts with DOE, NREL and several industrial firms. IEC is concerned with providing the basic research to allow the laboratory scale research to be scaled up to commercial scale manufacture. It received a DOD DARPA substantial grant for a cooperative team effort to proceed to a pilot scale operation. This was successful and led to the formation of two commercial firms producing $Cu(InGa)Se_2$ solar modules.

I have also had several years' experience as a process design engineer with Union Carbide Canada in which I supervised the design drafting and field construction of the processing units I designed (1), **Action/Innovation Team Type**.

The USA PV program as managed by DOE and NREL initially involved a **Science Discovery Team** at IEC, and several universities and two government laboratories. There appeared to be **Action/Innovation Teams** at various industrial concerns but their efforts were confidential.

In Professor Day's team definition; all his team types were involved. I will discuss our experience in terms of the leadership and "science" of team science.

The overall objective of part of the DOE is to develop renewable energy which will reduce our need for coal and petroleum products. The more specific objective of the photovoltaic program was to produce inexpensive energy using sunlight to directly produce electricity at a competitive cost. If there is a "science" to team science it is critical to thoroughly understand the **GOAL** which must be achieved.

Secondly although one does not like to stress the materialistic aspect of the "science" of science teams they cannot function without **ADEQUATE FUNDS** which must be properly managed.

For various reasons there is always a **TIME CONSTRAINT** on any project in the real world and can have a serious impact on the quality and nature of the science.

UNCERTAINTY is always present and almost always affects the management of any science team.

Let me try to illustrate these issues with my own experience developing a commercial scale process for producing thin-film modules of Cu (InGa)Se_2

In the early 1980's there were several large oil companies operating facilities attempting to produce photovoltaic modules (**Action/Innovation Team Type)**.

Several university researchers were engaged in **Science Discovery Team** research which in the main was not producing research meeting the overall DOE objective. The IEC at the University of Delaware modified its **Science Discovery Team** research to an **Action/Innovation Team Type** by appointing a chemical engineer as IEC director. Our successful technical efforts to impact and redefine the DOE/NREL broad goal were not having much impact when the University moved a group of Political and Public Policy faculty into the IEC laboratory because their own offices were being revamped. This move had the effect of an interaction in which they learned something about our technical work and we learned about how to deal much more effectively with politicians and government policy makers. We then began to affect the **Multiteam Systems** and were able to impact the approaches to photovoltaic research at other university, industrial and government laboratories. **Action/Innovation** requires that a process unit be designed and built which will produce a product useful to society. Such a requirement means that the laboratory scale research produce information need for eventual process design in addition to any "basic" research that motives the **Science Discovery Team** research. This can almost always be done with little extra effort. The research objectives need to be modified to reflect the ultimate goal more clearly.

IEC began research on what we termed photovoltaic unit operations in the early 1980's and designed and built equipment to continuously deposit the semi-

conductor layers a solar module on a moving flexible substrate. We were able to do this after we modified the laboratory scale apparatus to give us information on the rate at which we deposited the copper, indium and selenium on the small substrates in a physical vapor deposition batch system. This effort is described in detail in a paper entitled Photovoltaic Unit Operations published in 1982. (2). More recent accomplishments and comments on IEC's impact on the US Photovoltaic program are described in a paper published 2009 (3)

References

(1) T.W.F. Russell How to Design a Multi-Purpose Plant, Petro Process Engineering Vol. 45 No. 12 p. 70 December 1961

(2) T. W. F. Russell Photovoltaic Unit Operations. Chemtech, 1982, 12, 540-545

(3) Gregory M. Hanket, Robert W. Birkmire, Scott C, Jackson, Richard E. Rocheleau Role-to-Role Deposition of a Semiconductor Layer on a Flexible Substrate: Conception to Reality

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