TECHNOLOGY MANAGEMENT AT UNIVERSITY RESEARCH CENTERS

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Abstract

Technology Management seeks to make more efficient and effective use of technology and its development. In our modern age dominated by rapidly changing technology, effective technology management is critical for organizational success. University research centers are driven towards complexity, not only from the intricacy of the technologies that are investigated, but also because of changes in the way research is done. Resource constraints demand increasing interdisciplinary collaboration among universities, industries, and governmental agencies. This added complexity should create a demand for improved methods and tools for technology management and research. However, few of these efforts are evident in the literature. It must be kept in mind that management efforts to improve performance through increased control and planning can also stifle creativity and loose some of the most promising opportunities from the research effort. This paper reviews an approach to enhance the productive capabilities of university research centers and its application to the Center for Infrastructure Engineering Studies at the University of Missouri-Rolla. Included are the design of a survey and planned group interaction session to generate self-assessment of the center and a prioritized list of activities to address the center’s major needs. The participants evaluated very favorably the value generated by the survey and group session.

Introduction

The role and value of research and development is being seriously challenged and reconsidered in recent years. The criticism has been that the yield from these investments is very slow and unacceptably low (Rouse and Boff, 1998). Therefore efforts are needed to improve the effectiveness and efficiency of R&D investments. The resources should be addressing the right question to provide technology that will generate as much value as possible (R&D effectiveness). At the same time research methods should make efficient use of the available resources.

Traditional management methods have limitations in the research environment. In the traditional approach management identifies needs, defines the required tasks to satisfy those needs, and measures the progress towards those goals over time. However, in research it is often not known how to reach the goals, nor how difficult the task will be. In addition, researchers that are driven to satisfy administrative requirements might not be able to follow up on more valuable and revolutionary ideas. A balance must be reached to encourage researchers to complete projects in a reasonable timeframe without substantially limiting their creative powers.

The objective of this research is to develop a technology management plan that includes balanced methodologies that enable a university research center to improve its effectiveness and efficiency and encourage the timely performance of R&D tasks without inhibiting discoveries. For these functions there are three basic approaches:

1) The ad hoc approach, which has no formal technology planning efforts;
2) The planned approach, which is a formal approach that provides well integrated technology audits, technology forecasts and technology road maps; and
3) The iterative approach is a compromise between the two previous approaches with an emphasis on organizational learning and communication.

The ad hoc approach is a common method to manage university research centers. Center directors and researchers determine the direction and methods that are to be used in the center through informal communication. This works well with experienced directors and researchers that have a good understanding of center operations and research opportunities and communicate well together. However their success depends greatly on the wisdom and judgment of the center director and a few key investigators.

The planned approach is very rational and strategic. It starts with a technology audit to understand the current situation with respect to the key technologies. Utilizing a number of tools, the changes in these technologies and
market opportunities form an assessment of future states that define many of the available threats and opportunities. Finally, technology roadmaps are developed that highlight the likely technologies that should be developed in order to achieve the identified opportunities. Many values are derived from this approach, but it is expensive because the individuals who develop these audits, forecasts and road maps must be highly qualified, and also, the process takes considerable time and resources.

The third approach, a compromise between the first two approaches, is more planned than the ad hoc approach, but much simpler than the planned approach. This approach is iterative, in which the results of the first phase of research impacts the design of the following phases. This allows for more focused action that addresses only the high priority issues. It is also more focused on communication and organizational learning by the center participants who actually do most of the assessment and analysis. The role for the technology management team is to create the environment in which the communication and learning can take place and act as a facilitator to team action. This approach generates quicker results with limited resources and fosters team building within the center. It helps identify the innovative capabilities of the center as well as its major strengths and weaknesses so that they can be addressed.

**Methodology**

For this research, we chose the iterative approach in order to improve over the basic ad hoc approach. It was chosen over the planned approach because it was consistent with the time and resources available to most university research centers. If the activities that provide the greatest value over the ad hoc process are utilized, it should make a more visible impact thereby encouraging the center to continue the support of the technology management efforts. The iterative cycle, shown in Figure 1, includes assessment instrument design, application to the center, analysis of the results, discussion on the results of the assessment, identification of actions that would improve the situation, process documentation, and preparation for the next cycle.

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**Figure 1.** Technology Management Iterative Assessment Cycle

The process includes the creation of the technology management team who provides the direction for the process, administrative support in the application of the tool, analysis of the results and the assessment session, facilitation of the assessment session and documentation of the process, and provide continuity to the following steps.

The Innovative Capability Audit (Burgelman and Maidique, 1988) was chosen as the assessment instrument for the first cycle. The advantage is its ability to assess the center capabilities within the different phases of the innovation process, simultaneous with the assessment the different elements of innovative capability. This enables the assessment process to capture strengths and weaknesses in specific functions or phases. The Innovative Capability Audit is modified to fit the activities of the center and presented to the center members as a survey questionnaire. The assessment session is a planned group activity and is the key activity of the methodology. The objectives of this session are to:
• Share the results of the self-assessment with the center participants,
• Provide an opportunity to reflect on a strategic perspective of their center,
• Provide an opportunity to build teamwork and develop a common vision,
• Validate the results of the self-assessment,
• Discuss action that could improve the situation for the center,
• Prioritize the recommendations to center management, and
• Provide feedback to the technology management team on the value generated.

**CASE STUDY: Application Of The Process At The Center For Infrastructure Engineering Studies At The University Of Missouri-Rolla**

The Center for Infrastructure Engineering Studies (CIES) is a new research center at the University of Missouri-Rolla that focuses on applications of advanced composites for infrastructure. The Center Director wanted to develop an interdisciplinary team-based structure and allowed the researchers to apply this technology management process to the center. In order to identify the center’s strengths and weaknesses the Innovative Capability Audit was modified to the Center’s activities. The phases of innovation were determined as: needs analysis, discovery, process development, process validation and technology transfer. The elements of technological capability were identified as:

- **Resources**: equipment and laboratories, personnel, and access to information;
- **Strategy Formulation**: internal strengths and external forces (awareness of events, and recognition of their importance); and
- **Implementation**: organization, culture and communication.

From these phases and elements the survey form was developed. These forms were submitted to the faculty, staff, students and center customers so that the perspectives of each of these groups could be determined. A definition of each of the terms was documented and the participants were given individual assistance to encourage them to respond to the survey. Table 1 presents a summary of the results, segregated by the respondent type, based on 21 responses.

**TABLE 1**
SURVEY RESULTS BY RESPONDENT TYPE

<table>
<thead>
<tr>
<th></th>
<th>Faculty</th>
<th>Students</th>
<th>Staff</th>
<th>Total Center</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RESOURCES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment &amp; labs</td>
<td>2.60</td>
<td>2.57</td>
<td>3.15</td>
<td>2.66</td>
</tr>
<tr>
<td>Personnel</td>
<td>2.57</td>
<td>2.47</td>
<td>2.75</td>
<td>2.49</td>
</tr>
<tr>
<td>Access to information</td>
<td>2.43</td>
<td>2.20</td>
<td>2.60</td>
<td>2.30</td>
</tr>
<tr>
<td><strong>STRATEGY FORMULATION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal strengths</td>
<td>2.23</td>
<td>1.84</td>
<td>2.75</td>
<td>2.08</td>
</tr>
<tr>
<td>(Intellectual capital)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>External forces</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aware of events</td>
<td>2.23</td>
<td>2.07</td>
<td>2.60</td>
<td>2.22</td>
</tr>
<tr>
<td>Recognize importance</td>
<td>2.23</td>
<td>2.11</td>
<td>2.35</td>
<td>2.20</td>
</tr>
<tr>
<td><strong>IMPLEMENTATION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organization</td>
<td>2.43</td>
<td>2.37</td>
<td>2.65</td>
<td>2.44</td>
</tr>
<tr>
<td>Culture</td>
<td>2.43</td>
<td>2.21</td>
<td>2.35</td>
<td>2.25</td>
</tr>
<tr>
<td>Communication</td>
<td>2.60</td>
<td>2.32</td>
<td>3.70</td>
<td>2.64</td>
</tr>
<tr>
<td><strong>OVERALL</strong></td>
<td>2.42</td>
<td>2.24</td>
<td>2.77</td>
<td>2.36</td>
</tr>
</tbody>
</table>

The numerical score represents the average score of the responses for each of the survey questions. In this study a score of 1 represented the best. A score of 2 represented good, or a leader. Three represented adequate, or average. Four represented lacking, or a follower. Five represented need improvement, or just starting.
Reviewing these results, the students had the most positive results with an overall score of 2.24 and scores of 1.84 for internal strengths and 2.07 for awareness of technologically important events. The students viewed the major barriers to be the lack of resources in equipment and laboratories, with a score of 2.57, and lack of personnel with 2.47. The staff was the most critical, with an overall score of 2.77. The weakest areas were communication with a score of 3.7 and equipment and laboratories with 3.15. The strongest areas were the ability to recognize the importance of external technical news and implementation culture, both with a score of 2.35. Faculty was between the two other groups with an overall score of 2.42. The strengths were in all the areas of strategy formulation with a score of 2.23. The major barriers were in lack of equipment and laboratories and communications, both with a score of 2.6.

The next step in the process was the self-assessment session during which, the students, faculty and staff of the center discussed the results of the survey. The two-hour session included:

- The presentation of the results by the technology management team. The results from the survey were represented in the self-assessment session in detail as well as in the form of a color chart, which showed the areas of strengths and weaknesses as different colors.
- Discussion in break-out groups facilitated by members of the technology management team,
- Development of recommendations for improvement by each of the break-out teams,
- Discussion of the recommendations by the participants,
- Individual voting to prioritize the recommendations, and
- Individual surveys assessing the value generated by the technology management process.

The value survey results were very positive. Even though many of the participants had expressed hesitation about attending the session, the average score from the 16 respondents reflected very high expectations of results from the session. The average participant estimated that there was a 67% chance that moderate improvements would result from this effort.

**Conclusion**

The proposed technology management process provides a straightforward and valuable approach to improve the effectiveness and efficiency of university research centers. It makes use of tools developed for technology management in a participatory environment, and provides an opportunity for reflection in strategic thinking, team building, improved communications and organizational learning.

**References**


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