ABSTRACT

Quad charts that have been primarily used in government procurement are finding their way into the area of software project management. We present an overview of quad charts, describe their use in software project management, and discuss three different methods of their construction. Implications for the use of quad charts in the curriculum are addressed.

INTRODUCTION.

A number of approaches are available for project selection. Various numerical measures taught in undergraduate software project management courses include payback period, Net Present Value (NPV), Internal Rate of Return (IRR), Expected Commercial Value (ECV) and Decision Trees. [1] We examine quad charts as a tool in software project selection. Quad charts are known to be significant in the federal procurement process for scientific and research funding due to the leadership role of the Technical Support Working Group (TSWG). The Department of Defense Instruction 5000.2 (dated May 12, 2003) prescribes for paper studies to look at alternative concepts for technology development. [2] Quad charts are a good match for rapid development of alternative concepts in technology and software development. The utility of quad charts has recently surfaced in other areas including executive reviews, databases of research material, and project management. [3] Recently, Six Sigma companies have found the usefulness of quad charts in project selection. [4]

In this paper, we will discuss the general background for quad charts development, their place in software project management, and examples of quad chart
construction. We conclude with recommendations as to their place in the study of project management at the undergraduate level as part of a computer science curriculum.

**BACKGROUND.**

Four quadrant (2x2) systems have long been used in the analysis of information systems and process management. An early use is attributed to Warren McFarlan, who proposed the use of grid systems, breaking problems down into four parts, configured as a 2x2 matrix. [5, 6] McFarlan visualized the categories of information systems for various types of businesses in terms of the strategic impact of application software systems (horizontal axis) versus the strategic impact of existing operating systems. An adaptation of McFarlan’s grid categorizing information systems into four different types based on these two axes is seen in Figure 1.

<table>
<thead>
<tr>
<th>McFarlan’s Grid</th>
<th>Strategic Impact of Application Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>SUPPORT SYSTEMS (Manufacturing)</td>
</tr>
<tr>
<td>Strategic Impact Of Existing Operating Systems</td>
<td>TURNAROUND SYSTEMS (Retail)</td>
</tr>
<tr>
<td>High</td>
<td>FACTORY SYSTEMS (Distribution)</td>
</tr>
<tr>
<td></td>
<td>STRATEGIC SYSTEMS (Financial Services)</td>
</tr>
</tbody>
</table>

**Figure 1 – McFarlan’s Strategic Grid**

The concept of the Plan-Do-Check-Act (PDCA) Cycle was originated by Walter Shewhart of Bell Labs, who was a pioneer of statistical process control during the 1930’s. PDCA has also been used since the 1950s in W. Edwards Deming’s approach to Quality Management. The PDCA Cycle consists of four stages:

- **Plan**: Improve operations by determining the problems to overcome, as well as ideas with which they may be overcome.
- **Do**: test the proposed solutions in a small or experimental scale to minimize any disruption in routine activities.
- **Check**: Determine if the small scale or experimental changes are achieving the desired result or not.
- **Act**: If the tests were successful, implement the changes on a larger scale. The cycle may be repeated until the desired result has been achieved. As we can see in Figure 2, the PDCA cycle actually forms a four quadrant chart. [7]

<table>
<thead>
<tr>
<th>DO</th>
<th>PLAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHECK</td>
<td>ACT</td>
</tr>
</tbody>
</table>

**Figure 2 – Four Quadrants of the Plan-Do-Check-Act Cycle**

Four-quadrant relationships such as PDCA have been used in human and computer systems engineering and knowledge management to describe evolutionary processes. [8]
The SWOT framework [9] is a well known strategic planning instrument that is used for project management. Internal factors (strengths and weaknesses) are examined with respect to external factors (opportunities and threats) to help match resources and capabilities to the competitive environment in which a firm operates. An example may be seen in Figure 3.

<table>
<thead>
<tr>
<th></th>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opportunities</td>
<td>S-O strategies</td>
<td>W-O strategies</td>
</tr>
<tr>
<td>Threats</td>
<td>S-T strategies</td>
<td>W-T strategies</td>
</tr>
</tbody>
</table>

**Figure 3 – SWOT Chart**

The importance of quad charts is underscored by their position in the first-step of the bid submission process of TSWG. (http://www.tswg.gov) The need for technological developments forms the basis of TSWG’s Broad Agency Announcements (BAAs), wherein the government solicits innovative technology research and development solutions to problems facing over eighty federal agencies. TSWG organization will request more detailed information only after a positive review of a one-page quad chart. The brevity of quad charts performs two important functions:

- Minimizes entry barriers and constraints that might deter the discovery of innovations, especially by smaller companies; and,
- Values and conserves the time of the research sponsors and applicants; the number of initial quad charts that are submitted in a year can total well over 100,000.

**QUAD CHART STRUCTURE AND CONTENT.**

A survey of twenty-five commercial and governmental websites has revealed three basic formats for quad charts. The traditional TSWG quad chart configuration [3] is a simple structure formulating a low-tech solution to a complex problem. Sensemaking is the building of a collective understanding of a situation. [10] Management tools such as quad charts can perform valuable functions within a sensemaking process to capture and crystallize content. The traditional quad chart structure for response to BAAs is seen in Figure 4. [3]

<table>
<thead>
<tr>
<th>PROJECT TITLE</th>
<th>GRAPHICAL IMAGE. A visually appealing picture or graphic that represents the key technological idea(s) or the expected impact of the research.</th>
<th>NEW IDEAS/INNOVATIONS. Three or more new technical ideas embodied by the work.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BENEFITS. Three or more quantitative statements discussing how this work will revolutionize an area of importance</td>
<td>SCHEDULE. Four or more scheduled events or project milestones depicted on a horizontal timeline.</td>
</tr>
<tr>
<td></td>
<td>ORGANIZATION &amp; NAME OF PRINCIPAL INVESTIGATOR(S)</td>
<td></td>
</tr>
</tbody>
</table>

A somewhat different configuration is found for a Six-Sigma Project Quad Chart. Three real-world questions that are examined when Six Sigma companies are in the project planning and selection phase are ways to reduce defects, reduce process cycle time, and reduce resource consumption. Once key elements are identified, they are summarized in a Quad Chart to be used during the actual selection process. [4]
While the Six-Sigma quad chart has the basic elements as the previous example, its focus is on quantifiable results, as well as detailing how the Six Sigma process will play a key role in the project. The quadrants include:

- Q1 (upper right): Current Process Impact, including statistics from current running processes to be improved upon completion of the project
- Q2 (upper left): Problem/Need Statement, including text defining the problem and intended, quantifiable, improvements to be made upon completion of the project
- Q3 (lower left): Six Sigma Objective Benefit, stating how Six Sigma will be used, as well as specific benefits of its application
- Q4 (lower right): Milestones and Deliverables

In a third quad chart format, the following quad chart template [11] shows several additions and rearrangements from the traditional quad chart above. The extensions allow the document to be updated through the lifetime of the project, making this a more extensible and reusable project management tool.

<table>
<thead>
<tr>
<th>PROJECT TITLE</th>
<th>TECHNOLOGY. Description of technology and capabilities (no more than three lines)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OBJECTIVES. List of the objectives and a description of a successful project outcome.</td>
</tr>
<tr>
<td>PARTICIPANTS.</td>
<td>FUNDING. List of all funding sources by fiscal year and a total by funding source.</td>
</tr>
<tr>
<td>SCHEDULE.</td>
<td>BENEFITS. Listing of cost savings, reduction of cost and resources as a result of the project, and a brief implementation plan.</td>
</tr>
<tr>
<td>PROJECT STATUS.</td>
<td></td>
</tr>
</tbody>
</table>

Figure 5 – DOD Quad Chart

After a proposal has been selected for funding and converted to a project, the lower left quadrant will give a Status of the ongoing project and omit the Schedule. Participants may also be moved from the lower left quadrant to the upper left quadrant if additional space is needed. Such modifications make the DOD quad chart easy to integrate into project management reporting activities.

A TSWG QUAD CHART EXAMPLE.

Figure 6 shows an example of a quad chart that was constructed prior to the development of AOPHP Version 2.0, an aspect-oriented extension to PHP. (http://www.aophp.net) The quad chart was developed as closely to the TSWG guidelines as possible. It was used by the developers to provide a fast explanation of the project at the AOSD 2005 conference (http://www.aosd.net/conference). A large majority of visitors to the AOPHP exhibition had no problem understanding the project, even with no real experience with PHP.
IMPLICATIONS IN PROJECT MANAGEMENT EDUCATION.

Quad charts are currently being studied in undergraduate project management and related courses by the authors at NC State University in Raleigh and at Coastal Carolina University in Conway, SC. The material for quad charts comprises a unit of approximately one week. The intended learning outcomes for the unit are as follows:

- Understand how quad charts have been used to analyze information systems (McFarlan), how they model the PDCA cycle as it applies to software quality (Shewhart, Deming), and information system competition strategy (SWOT);
- Understand three different strategies for creating quad charts for technology and software development – TSWG, Six Sigma, and DoD; and,
- Know how to create a quad chart that will fit into the project selection phase of managing projects:
  - The inputs to the quad chart come from project needs of the stakeholders, as they look for innovative software and technology to solve problems or facilitate process improvement; and,
  - The outputs from the quad chart phase are used to generate a Project Selection Matrix, the foundation of a decision tree based on criteria such as Earned Commercial Value (ECV). [1, pp. 27-32]
CONCLUSIONS.

Quad charts, originating from the federal procurement process, have an important and practical position in the area of software project management. Once a set of goals have been reached by project stakeholders, quad charts allow vendors to propose technical solutions to project goals without the expense of a tremendous amount of time or resources. Quad charts then allow the stakeholders to more accurately evaluate the technology and software needs of a project prior to formal project selection. They reduce the overhead of reading lengthy proposals in the very early stages of a software project. Based on their practicality and increasing acceptance, quad charts are an important part of software project management that should be taught in the undergraduate curriculum.

REFERENCES.


