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SIMULATION ASSISTED PRODUCT DEVELOPMENT PROGRAM PLANNING

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ABSTRACT

Numerous industries, including those in the automotive and pharmaceutical industries, use a program approach to product development. Companies must plan the start times of programs in order to meet future revenue requirements. At the same time, companies perform resource planning to set targets for human and capital requirements. Traditional spreadsheet analyses lack the ability to incorporate variability in program arrival patterns, program phase lengths, program resource needs, and program success. The implication of this static analysis is an often inaccurate view of programs, resources, revenues and costs in the future.

This paper describes an implementation of program planning utilizing discrete event simulation. The benefits of this approach are described, including 1) a flexible input mechanism for capturing the planner's assumptions, 2) approaches to introducing variability into the analysis, and 3) organization of the results in an easy-to-use format.

1 INTRODUCTION

Industries that take a program approach to product development historically use static tools such as spreadsheets, project management software, PERT, and CPM methods to both schedule and staff projects. However, it is difficult to find a project manager that is not aware of the variability and Murphy's Law impacts on the successful completion of a project while meeting business objectives (e.g. on-time and under budget). The previously mentioned methods do not account for the uncertainties in product development; yet industry is demanding that new tools do.

A resource management tool is needed that accounts for variability in phase lengths, attrition, resource requirements and arrivals of new projects. By incorporating these characteristics of product development, management may better understand when and where the bottlenecks in the process are located. In addition, the program planning tool needs to be able to experiment with a resource unconstrained scenario, so that management can gain valuable insights into staffing requirements by FTE specialty.

Effective use of resources to decrease program cycle time is vital in the pharmaceutical industry. Drug patents are obtained while drugs are still in development. Because patent life is limited, the faster a company can bring a drug to market, the more time it will have to generate revenue from that drug. At the end of the patent life, very little to no revenue is generated. In this industry, the benefit from delivering a program to the market one week earlier can lead to a multi-million dollar increase in net income.

The pharmaceutical company analyzed in this study researches the discovery of new pharmaceutical drugs in 6 different categories: Prototype, Back-Up, Biologics, Second Generation, Fast Follow-On, and Alliance. They have specific corporate goals for how many of each type of drug they want to proceed to their drug development process. Their goals are more aggressive with each successive year. In addition, the company is reengineering their drug discovery business processes such that the number of drugs that successfully complete the process, probability of attrition, phase lengths, and the number of resources required change each year too.

Attempts at spreadsheet analyses were unsuccessful, cumbersome, and not user friendly, and the company realized several drawbacks of analyzing this process with a static tool. These limitations included the inability to create a spreadsheet model 1) incorporating realistic program start dates; 2) incorporating the variability found in program phase lengths; 3) reflecting the randomness found in program success rates; 4) allow for cycle time and success rate improvements over time; and 5) predicting with a reasonable degree of accuracy the number of resources required to complete programs. They recognized the importance of capturing the numerous areas of variability was critical in order to make an informed decision regarding staffing levels across the process.

Andersen Consulting's Capability Modeling and Simulation (CMAS) group developed a program planning tool to aid the company in their staff planning while taking into account their business goals and reengineering efforts. The company uses this program planning tool daily to make current and future staffing decisions, and to test their business goals as well as their reengineering efforts. The tool is user friendly, accounts for the variability throughout product development, and produces the output in an easy to read summary.

2 APPROACH

Andersen Consulting developed an initial understanding of the drug discovery process through mapping the drug discovery process at a high level. Subsequent meetings with company representatives led to the level of detail that they believed they needed to have in a tool in order gain the insight they needed to make staffing decisions, and at a level which they felt comfortable making assumptions about the process. The company also identified what elements of the process they wanted to be able to easily change in order to run their staffing experiments.

Once this initial information was gathered, a simulation model of the company's drug discovery process was developed in Arena®. The process includes the development phases within drug discovery, along with the processing times, resource requirements, and success probabilities of each phase. While the process at this level of detail is relatively simple, the key to the entire simulation is the flexibility for experimentation it provides the client through a front- and back-end interface.

The model's flexibility is achieved through extensive use of variables in simulation modeling constructs versus constants. Constants would require the user to enter each module individually and make the necessary changes. This facilitates 2 important keys to the successful implementation of this type of tool: 1) A Graphical User Interface (GUI) using Visual Basic for Applications (VBA) could be developed that writes the necessary information to these variables, and 2) The model could be run on desktops with only Arena® Viewer versus a full version of the software.

The GUI allows the user to change the following model parameters:

- The number of drugs desired to successfully complete the drug discovery process by drug type by year.
- The number of resources that are available by resource type by year.
- An option to run the model using these resource constraints or to run resource unconstrained.
- The minimum, most likely, and maximum (triangularly distributed) phase lengths by drug type by year by process phase.
- The attrition rates by drug type by year by process phase.
- The resource requirements by drug type by year by process phase.

The arrival rates are determined by taking the goals and the attrition rates into account simultaneously. The arrival of each drug type is modeled as a Poisson process.

With the process translated into a simulation language and a GUI to facilitate experimentation, the simulation adds the variability in arrivals, phase lengths, and the successful completion of the process.

During the simulation, output statistics are written to a Microsoft® Excel workbook, once again using VBA. Upon completion of the simulation, these output statistics from the replications are summarized in different worksheets. Outputs include the following:

- The GUI inputs for this experiment.
- The number of successful drug discoveries by drug type by year.
- The minimum, average, and maximum Work In Process (WIP) by drug type by process phase by year (and month)
- The minimum, average, and maximum WIP by drug type by process phase by year (and month)
- The minimum, average, and maximum WIP by drug type by year (and month) process wide.
- The minimum, average, and maximum number of resources required by drug type by functional area by year (and month)
- The minimum, average, and maximum number of resources required by year (and month) process wide.

The ability to use the full functionality of VBA to package a simulation between a front- and back-end is critical to this program planning tool and one of the reasons for its successful acceptance at the company. The simulation modeling complexity is not seen or modified by the user and aside from running Arena® Viewer, the use of discrete event simulation is transparent to the user.

3 RESULTS

The program planning tool accounts for the variability of arrivals, phase lengths, attrition, and resource requirements over time with an easy to use interface and summarized outputs making up for the drawbacks of static tools. All of these features would not have been possible had it not been for the use of discrete event simulation as an engine packaged inside of VBA. Examples of the GUI are displayed in Figures 1 and 2.

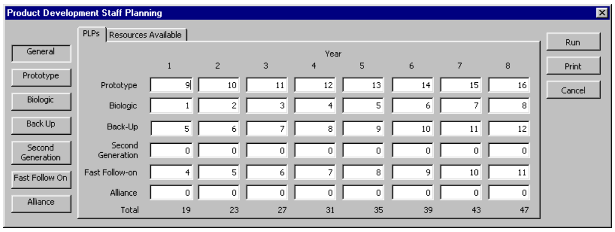

Figure 1: Graphical User Interface

The program planning tool may be executed on any desktop that has Arena® Viewer installed. A run finishes in 10 minutes on a Pentium 333 MHz desktop. After the run completes, the user views the statistical output in the user-defined summarized spreadsheet. Examples of the outputs are in Figures 2 and 3.

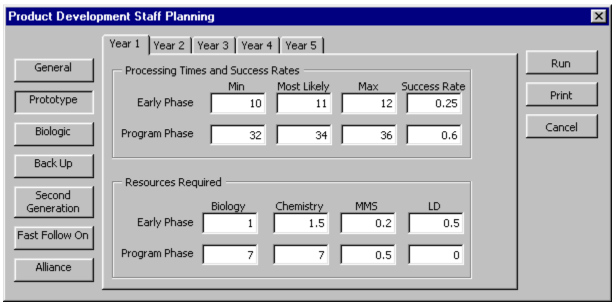

Figure 2: Graphical User Interface

The company is actively using the program planning tool on multiple desktops to determine short term and long term staffing requirements for their drug discovery process. They also recognize the value that simulation provides and its strengths above typical project development tools.

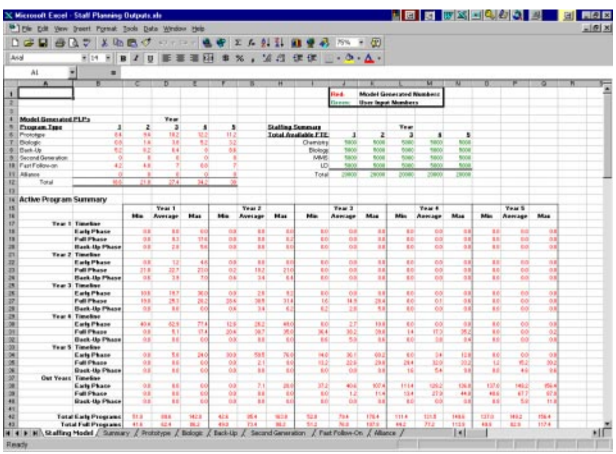

Figure 3. Output Example

Andersen Consulting is leveraging their knowledge of the power and possibilities of such a program planning tool on other engagements. The various and extensive staffing needs of many industries will enable the conceptual reuse many times over.

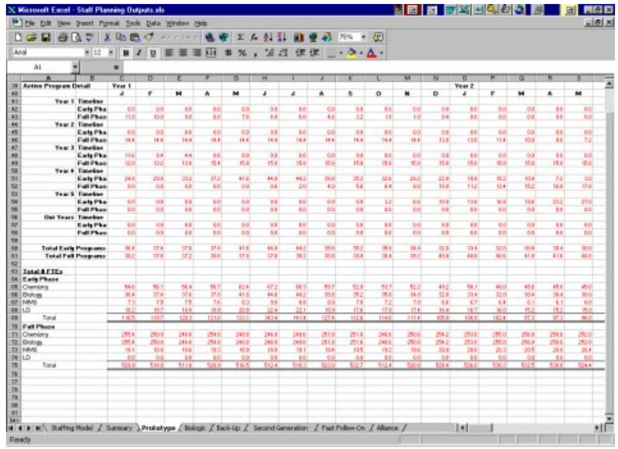

Figure 4: Output Example

4 CONCLUSIONS

Simulation makes up for the deficiencies of traditional staff planning tools. The incorporation of variability in arrivals, phase lengths, and attrition rates provides the user with more useful and accurate insights to their business concerns. Application of simulation to this and other areas of product development can provide significant benefit to companies looking to reduce development lead times and to efficiently use professional resources.

The usefulness of simulation in this environment is facilitated by the flexibility that programming in a Microsoft® Office environment provides. The VBA portion of this program planning provides the user with the value through flexibility and ease of use; however, it adds a significant software engineering effort often overlooked in simulation project management. Not only does adequate time need to be allotted for programming the GUI but even more time is needed for testing and error trapping.

Since the intent of the GUI is that a non-expert user can use the tool, the GUI needs to guide them through data input, but it also needs to catch input mistakes that would cause errors in the execution of the simulation. Some common areas for error trapping include:

- For a triangular distribution, the minimum must be strictly less than the mode, and the mode must be strictly less than the maximum.
- Negative numbers entered for processing times, attrition rates, or business goals.
- Text or characters entered where numbers are expected.
- The impacts of a wide range of inputs on the outputs.

Adequate time must also be allocated to test the following areas of the GUI:

- Ensure the error trapping is working.
- Testing the assumed distributions given varying inputs for business goals and processing times, i.e. exponential interarrivals and triangular processing times.
- Output statistics are calculated correctly.
- All perceived functionality is working properly, i.e. selecting “Cancel” ignores any previous input versus selecting “Run” which must use to the previous input.

Packaging a simulation within a front- and back-end changes a simulation modeling from a “fuzzy” software engineering project into an actual software engineering project.

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