Design of a Grant Proposal Development System

Proposal Process Enhancement and Automation

Giselle Sombito, Pranav Sikka, Jeffrey Prindle, Christian Yi

George Mason University

Systems Engineering & Operations Research Department

Fairfax, VA, USA

Abstract— **Grant research has been the pinnacle of growth for many decades. It initially began as military research where technology improvements were only made by the hand of the government. However, it was later realized that research in the hands of civilians, mostly academics and scholars, could help to advance and improve technology much more quickly. From here, universities across the country have aided in research in all fields and have sought to improve the quality of life all around. In the enterprise of grant research lies the proposal process. This is where proposals are written by proposal writers in response to a solicitation from an agency in hopes of receiving funding for a specific area of research. George Mason University (GMU), every year, sends approximately 1000 proposals to different government agencies in the United States to receive funding for research. From these 1000 proposals, it has been found that approximately 50% of proposals are rejected and 14% are still pending, of which, more than half, if not all, will be rejected. The average proposal writer at GMU spend approximately 21 days writing a proposal, which based on average salary, is a $3,864 investment, and would be a loss if the proposal does not win. A lot of proposal losses can be due to non-technical aspects of the proposal process that does not include the actual research content, such as document gathering, proposal formatting, and more. Automation of these non-technical aspects of a proposal will help to increase the probability of a winning proposal.**

Keywords- proposals, grants, cloud, solicitations, budget, COEUS, Office of Sponsored Programs

I.   INTRODUCTION

The whole enterprise of grant research involves three main stakeholders, the government, academic institutions, and the researchers. The goal of this enterprise is to perform research to improve the quality of life. Professors and scientists employed by academic institutions are encouraged to perform research for these purposes, obtain knowledge and improve life. Government Research and Development efforts grant funding to Academic Institutions and research professionals, who they think would best deserve the funding and could be able to further the research. The researchers, on the other hand, receive funding to perform their intended research. These researchers write to prove to the government agencies that they have the best ideas and capabilities to deserve the funding they need by submitting research grant proposals. Their research grant proposals must be of good quality and must meet requirements and research goals of the agency. Researchers are encouraged to perform research by academic institutions by imposing requirements in order for them to receive tenure. Within this enterprise, lies the proposal process in which proposal writers respond to solicitations in hopes of writing a winning proposal.

Once the PI has chosen a solicitation, they begin working on the proposal. The PI begins by deciding if a team is needed. Teams can vary from one member to having multiple universities work on a joint proposal. The PI then has to go through and search for the specific agency requirements, such as formatting guidelines, required supplemental documents, and general proposal guidelines for that agency. There are also some requirements that are specific to each proposal that are provided in the solicitation. A lot of time is spent here gathering all relevant information.

The next step is for the PI to fill out the "Request for Assistance" form, which begins interactions with OSP. OSP is able to obtain the necessary information about the proposal and about the PI. The OSP primarily helps the PI draft and prepare the budget of the proposal. The OSP then inputs information, from a template that the PI completes, into the COEUS software, a proposal management software that outputs a formal budget. Any changes to the budget by the PI must be justified and then resubmitted to OSP and into the COEUS software and then back to the PI. This is repeated until the budget is correct.

During this time the PI is working on the proposal and the OSP also has been gathering the required supplemental documents, some of which need to be signed and routed to the correct locations. Upon completion of the proposal, the PI submits the proposal to the OSP for final review. OSP requires a four-day period to review each proposal before final submission to the funding agency.

Despite the requirement of the four-day review period, about 69% of proposals are submitted with less than four days to review which forces the OSP to condense their review leading to potential oversights. After the OSP reviews the proposal and they have gotten all required forms signed and routed, they submit the complete

proposal package to the funding agency for review. The funding agency eventually gets back to the PI with their final decision, however it often takes months or years for a proposal to be accepted or rejected.

Every year George Mason University sends approximately 1000 proposals to varying government agencies. It has been found that approximately 50% of those proposals are rejected and 14% are pending. It can be assumed that more than half, if not all, of the pending proposals are rejected. The average proposal writer, or PI, spends about 21 days completing a proposal. This is a

university as to how much work they must do for a proposal in order to become a tenured professor. Therefore, a winning proposal not only helps to advance their research, but it helps to advance their careers at the university for tenure-track professors.

Lastly are term professors who are hired on contracts and also have requirements as to how much work they must put into proposals. They are also required to pay for their own research giving them more incentive to write winning proposals.
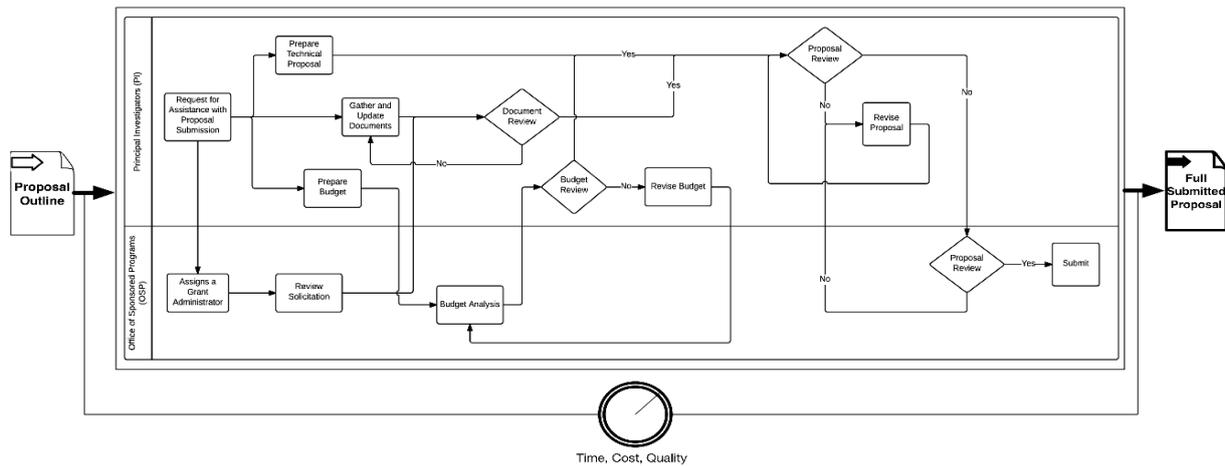

Fig. 1 Formal Grant Proposal Development Process at George Mason University

$3,864 investment and it is lost if the proposal does not win. A lot of proposals can lose due to improper handling of the non-technical aspects of the proposal, and automation of these non-technical aspects will help to improve the probability of a proposal winning.

Fig.1 represents the general proposal development process at George Mason University. The process begins when the sponsoring agency sends out a solicitation document, or a BAA. Currently the PI's spend a lot of time going through hundreds of emails that go out every day to try to find a BAA that is of interest to them.

II. STAKEHOLDER ANALYSIS

A. Proposal Writers

Proposal writers, or Primary Investigators, PI, are the ones who spend time doing research and complete the technical parts of the proposals. The proposal writers have relatively the most invested into the process and have the most responsibilities in making sure that the proposal, which is being worked on, meets the requirements set out by the sponsoring agencies. Proposal writers also have the most to gain.

At George Mason University, proposal writers are GMU professors and fall into one of three categories; tenure, tenure-track, and term professors. Tenured professors are the most senior and have no set requirements by the university as to how much work they are required to do for proposals and are usually driven by their own personal goals as to much work they wish to for a proposal. Tenure-track proposals are hired for a fixed term and have requirements set forth by the

B. George Mason Office of Sponsored Programs

The Office of Sponsored Programs, OSP, is an entity in the University that regulates the research being done by members of the community. They are concerned with assisting with the proposal budget development and proposal submission. The OSP reviews, negotiates and executes all contracts with the University that involve external funding.

One of their important roles is to review grant proposals to make sure that they are not violating federal and state laws, rules and regulations. The main task of the OSP is assisting in the creation of the budget for the project. They talk to the principle investigator and go through individual aspects of the project including funding for traveling, assistants, equipment among other things and come up with a budget that is submitted along with the proposal to the funding agency. The main objective of the OSP remains to assist the principal investigator with regards to the compliance of the budget.

C. Sponsoring Agencies

Sponsoring agencies are generally interested in research that has significance to their specific agency or foundation. They heavily invest, financially, in research that will help advance their cause or mission. In the proposal process, the agency sets the requirements necessary for a proper proposal to be submitted.

A proper proposal will have proper formatting set forth by the agency, follow all technical requirements and show promise in the research topic. A winning

proposal will be chosen by the agency and will be granted funding so that the research can continue.

D. Professional Organizations and Proposal Training Companies

Proposal training companies and professional associations exist to provide information and training to proposal writers. Their function is simply to provide information to PI's on aspects of the proposal process that they may not be familiar with and to provide networking opportunities for professionals to share information about the proposal process. These companies have no stake in the acceptance or rejection of the proposals other than potential marketing value if the PI, on the proposal, used their services and thought they contributed to the proposal being selected.

E. Stakeholder Tensions

The four stakeholders for the proposal system at George Mason University are the professor's, or principle investigators (PI), the Office of Sponsored Programs (OSP), the funding agencies, companies that provide training services for proposal writers and professional associations for proposal writers. The biggest tension during the process is about time allocation during the process.

The PI's want as much time as possible for technical proposal writing to make their proposal the best that it can be. At the same time the OSP wants their four-day period to review the proposals, more than 60% of the time the PI's take too long writing and the OSP does not get their four-day period. An overall tension of the entire process is the fact that there is no governing body for the overall process. Since no one is accountable for the entire process there are deficiencies throughout that lead to conflicts. The OSP for example has no stake in if a proposal is accepted or rejected therefore they have less incentive to make sure the proposal is correct.
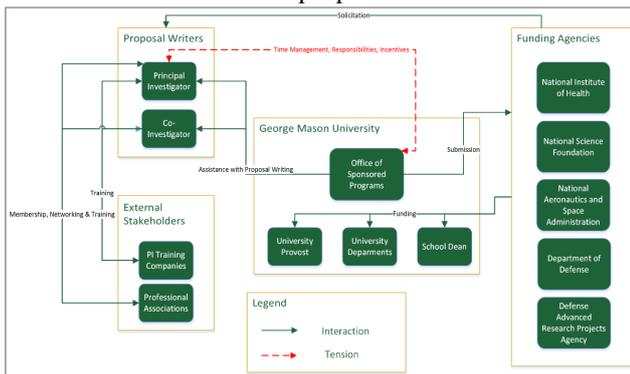

Fig. 2 Stakeholder Interaction and Tension Diagram

III. PROBLEM STATEMENT

Proposal writers invest time, which has a monetary value, in order to write and develop the best quality proposals they can to obtain funding. On average, proposal writers invest over 21 days, over $3,864, on a proposal. However, only approximately 30%** of grant proposals that are submitted by George Mason University receive funding. Grant proposals that do not get funding become losses to the proposal writer.

IV. NEED STATEMENT

There is a need to improve the processing of non-technical portion of proposals in order to reduce costs, avoid rework and duplicate effort, and reduce the investment losses.

V. CONCEPT OF OPERATIONS

The proposed solution is a system that will reduce the time inefficiencies of the system by better distribution time among important tasks as well as a better distribution of responsibilities among proposal writes and grants administrators. It will also provide an avenue for proper communication between the PI's and the GA's along with solicitation matching for the PI's.

	Solution	Design Alternative
Labor Intensive Tasks	Reuse of previous materials	Database Management System
	Collaboration	Document Management and Collaboration System
	Eliminate downtime	Proposal Tracking System Document Management and Collaboration System
	Supplementary Documents	Database Management System
Intellectual Labor	Matching PI's skills and experiences with Solicitation	Opportunity Management System
	Team Building	

VI. DESIGN ALTERNATIVES

The proposed design alternatives address three types of tasks associated with the process; labor-intensive tasks, decision-making tasks and quality related tasks by optimizing the resources used at the OSP, introducing a technology or a combination of both.

A. Additional OSP GA's

Hiring more OSP members, enough to have a member for each department on campus. This would increase efficiency by having the same GA working with the same PI's on each proposal therefore creating a working relationship. However, hiring more OSP members would be costly.

Tasks	Labor Intensive	Decision Making	Quality
Efficiency Gain	+10%		+5%

B. New Support Group

A separate department that is responsible for the whole proposal process, assisting both the OSP and the PI's. This department would assist with the review process by utilizing professors familiar with the technical field as well as English professors familiar with proper paper writing.

Tasks	Labor Intensive	Decision Making	Quality
Efficiency Gain	+20%	+20%	+5%

C. Databse Management System

A system that would store proposal requirements and templates specific to each funding agency. This would allow everyone involved in a proposal to review what is required.

Tasks	Labor Intensive	Decision Making	Quality
Efficiency Gain	+10%		+5%

D. Document Management and Collaboration System

A cloud based system that will allow proposal writers and OSP members to work collaboratively on the proposal simultaneously in order to reduce time inefficiencies. The system is tied to the database management system and will create templates based on the funding agency.

Tasks	Labor Intensive	Decision Making	Quality
Efficiency Gain	+20%	10%	+5%

E. Proposal Tracking System

This system can be tied to the database management system and the document management and collaboration system. Its function is to provide a status report of a specific proposal as it is being completed. The progress will be measured against the requirements of the proposal based on the funding agency selected. Users can provide updates as they complete tasks via a provided checklist.

Tasks	Labor Intensive	Decision Making	Quality
Efficiency Gain	+5%	+10%	

F. Opportunity Management System

This system would be used to match proposal writers with solicitations that match their area of expertise. This would eliminate the tedious and time-consuming process of sifting through emails and grant websites searching for appropriate solicitations. The user would create a profile consisting of their education and working experience; based on this profile the system will match them with solicitations.

Tasks	Labor Intensive	Decision Making	Quality
Efficiency Gain		+20%	+20%

VII. DESIGN OF EXPERIMENT

In order to determine the bottlenecks of the system, as it currently exists the process will be simulated as the baseline. The simulation will then be modified to test each design alternative. There will be a total of 18 different combinations of alternatives. The results from these simulation runs will be used as an input to a mathematical equation used to determine how the proposal win rate is affected. The table below shows the different combinations of these alternatives.

Sim Run	Configuration	Alternatives					
		A	B	C	D	E	F
1	Baseline						
2	A	x					
3	A, C	x		x			
4	A, C, D	x		x	x		
5	A, C, D, E	x		x	x	x	
6	A, C, D, E, F	x		x	x	x	x
7	A, F	x					x
8	C, D			x	x		
9	C, D, E			x	x	x	
10	C, D, E, F			x	x	x	x
11	C, E			x		x	
12	F						x
13	B		x				
14	B, C		x	x			
15	B, C, D		x	x	x		
16	B, C, D, E		x	x	x	x	
17	B, C, D, E, F		x	x	x	x	x
18	B, F		x				x

VIII. UTILITY ANALYSIS

The mathematical calculation of win rate will use the simulation results as well as properties of the proposals themselves, these properties include; PI qualifications, PI past performance, budget information, general requirements fulfillment and review time. These criteria will be given weights based on a utility analysis. Fig. 3 shows the value hierarchy established for the analysis.
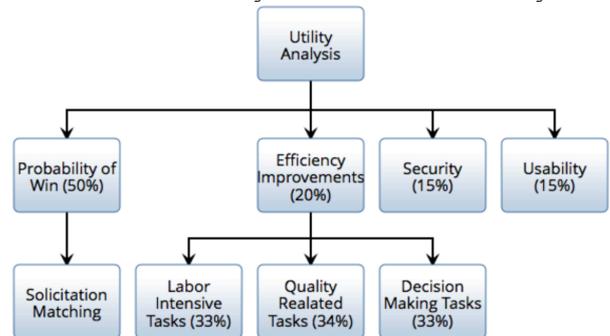

Fig. 3 Value Hierarchy

IX. METHOD OF ANALYSIS

The design alternatives will be evaluated using a Colored Petri Nets simulation that was created based on the process flow diagram of the system, as it currently exists. A baseline simulation model was created and run to verify its accuracy to the system as it is currently. The simulation determines how much time is required for a proposal to go through the proposal process. The simulation will be modified, time distribution changed and processes reorganized based on each design alternative.

X. SYSTEM SIMULATION

With the simulation, only the sub processes that involve the OSP will be manipulated in the simulation runs. This is because the behavior of PIs as individuals cannot be controlled since each one of them has a different method of preparing their proposals due to their other responsibilities in their day-to-day work. However, OSP interactions and OSP actions can be streamlined since their day-to-day actions in the system are their only roles in the University.

Those processes that are not effected will be provided a certain distribution, based on interviews or engineering estimates, and will be left unchanged between simulation runs. The sub processes that will be manipulated between runs include the budget preparation, document collection, document routing and the review. These are the sub processes that our proposed system will be able to change by making them more efficient and ultimately reducing the time required to complete them.

As shown in the snap shot of the baseline simulation, the process starts with the arrival of a solicitation or a blank proposal. The arrival rate was calculated using the data received from the Office of Sponsored Programs (OSP). From there it is first checked to see if the incoming solicitation is a Limited Submission or not. To process this, every incoming solicitation is assigned a 1% of being a limited submission since it is a rare occurrence. If it is processed as a limited submission it then goes through a separate process where it gets an added delay time, if not then it moves to the next sub process where it is assigned to a grant administrator. After this the proposal is split into two different sections, one side is the OSP and the other side is the Principle investigator or the PI.

The PI begins to work on the proposal and this process was given a separate distribution that was also calculated from the data received from the OSP, after the prep time the PI does the formatting and document gathering, both of which also have separate distributions. The OSP during this time works on compliance checks and their own document gathering. After these steps the OSP and the PI collaborate to work on the budget. Through the research performed, it was discovered that the budget is a repetitive process so to address that, a loop was incorporated that first generates a random number between 1 and 10 and goes through the budget loop that number of times.

After the budget the OSP gets the final copy of the proposal and gets to review it. The OSP requires 4 days to review each proposal, but it doesn't always happen. This sub process shows how many of the proposals actually make the 4-day period that is requested. After the review time for the OSP, the proposal is submitted.

The baseline model was run for a 1000 time units in CPN tools, this led to a total of 113 proposals being created and 109 of them actually submitted. Some preliminary results were obtained which corroborated the initial predictions based on the OSP data. The average time that the proposal spent in the whole system was 19.78 days, the average time from the OSP data was around 21. The time spent by a PI writing the actual technical content of the proposal was found to be approximately 13.94 days. The PI spent approximately 0.98 days on the formatting and general requirements for the proposal, and roughly 1.95 days on the document gathering sub process. The OSP and PI spent almost 3 days on the budget preparation which included the loops generated randomly. And the simulation results showed that the OSP had an average of 3.64 days to review the proposals, even though they require 4 days for that task. Another key statistic obtained was that only 36% of the total proposals met OSP's 4-day internal deadline, which validated the original prediction.

Sub-Processes	Duration
Total Preparation Time	19.78 Days
Writing Time	13.94 Days
Formatting/General Req. Time	0.98 Days
Budget Preparation Time	2.99 Days
Document Gathering Time	1.95 Days
OSP Review Time	3.64 Days
Internal OSP Deadline Reached	36%

XI. RECOMMENDATIONS

The next step for the project is to further simulate the process applying the different design alternatives. Along with that, utility analysis will be performed to determine which one has the most value to the system. Sensitivity analysis will also be performed to determine whether the alternatives are sensitive to the weight applied to the attributes in the utility function.

To further the analysis, a trade study of different available products in the market, that are being used by enterprises to write proposals, will also be performed looking at their capabilities and features based on the value hierarchy established. In line with this, the features and capabilities of the cloud-based application Innoslate will be studied to determine which can be used for the design alternatives that are most effective.

Knowing that the whole grant proposal process at George Mason University is a complex one that involves different areas and sub-processes, and that the scope of this study is on the formal proposal development process, future studies could further analyze the front-end part of the process which is determining the best proposals to write for which increases their chances of winning the proposal. It is also recommended to look at the other non-writing aspect of the proposal process which includes the politics of it since the grant proposal writing process is a social process.

XIII. REFERENCES

Interviews
[1] P. Costa, 2015.
[2] R. Ganesan, 2015.
[3] K. Laskey, 2015.
[4] M. Laskofsky, 2015.
[5] P. Brouse, 2015.

General

[6]   Bush, Vannevar. 'As We May Think'. The Atlantic. N.p., 1945. Web. 1 Dec. 2015.

[7]   DARPA, 'Doing Business with DARPA'.

[8]   Defense Procurement and Acquisition Policy, 'Department of Defense Source Selection Procedures', 2011.

[9]   Grants.nih.gov, 'Peer Review Process | grants.nih.gov', 2015. [Online]. Available:http://grants.nih.gov/grants/peer_review_process.htm.[Accessed: 20- Oct- 2015].

[10] Microgravityuniversity.jsc.nasa.gov, 'NASA - Reduced Gravity Student Flight Opportunities Program', 2015. [Online]. Available: https://microgravityuniversity.jsc.nasa.gov/theProposal/evaluation.cfm. [Accessed: 19- Oct- 2015].

[11] [Nsf.gov, 'US NSF - Merit Review', 2015. [Online]. Available: http://www.nsf.gov/bfa/dias/policy/meritreview/. [Accessed: 20- Oct- 2015].

[12] Renze, J.L. "Important Factors in the Technical Proposal Process according to Engineering Faculty." *IEEE Transactions on Professional Communication* 39, no. 2 (June 1996): 87–98. doi:10.1109/47.503272.

Data

[13] [Aaas.org, 'Historical Trends in Federal R&D | AAAS - The World's Largest General Scientific Society', 2015. [Online]. Available: http://www.aaas.org/page/historical-trends-federal-rd. [Accessed: 20- Oct- 2015].

[14] Glassdoor, 'George Mason University Tenure Track Professor Salary', 2015. [Online]. Available: http://www.glassdoor.com/Salary/George-Mason-University-Tenure-Track-Professor-Salaries-E22413_D_KO24,46.htm. [Accessed: 19- Oct- 2015].

[15] Higheredjobs.com, 'Professionals in Higher Education Salaries (Mid-Level Administrators) - HigherEdJobs', 2015. [Online]. Available: https://www.higheredjobs.com/salary/salaryDisplay.cfm?SurveyID=33. [Accessed: 19- Oct- 2015].

[16] [Nsf.gov, 'nsf.gov - National Patterns of R&D Resources - NCSES - US National Science Foundation (NSF)', 2015. [Online]. Available: http://www.nsf.gov/statistics/natlpatterns/. [Accessed: 20- Oct- 2015].

[17] Proposal Database, GMU Office of Sponsored Programs.

[18] Usaspending.gov, 'Data Archives', 2015. [Online]. Available: https://www.usaspending.gov/DownloadCenter/Pages/dataarchives.aspx. [Accessed: 20- Oct- 2015].