Oak Ridge National Laboratory (ORNL): A Functional Analysis of the Nuclear Nonproliferation Program

IE 422 Senior Problems Analysis, University of Tennessee

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Define:
Project Scope
Project Goals and Deliverables
Organizational Structure
Job Definitions and Tasks
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Measure:
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Project Scope

A functional analysis of the Nuclear Nonproliferation Program at Oak Ridge National Laboratory will be conducted to evaluate the functional needs of the program. The analysis will serve as a basis for strategic planning.

The analysis includes determining a functional definition, identifying effort area identifications, interviewing/data collection, and data analysis. A 3 to 6 month period of performance is expected, dependent on resource availability and ease of scheduling data collection. Data collection, summary and initial analysis will be performed by University of Tennessee Industrial Engineering students. Project management and summary reporting will be provided by Sharon Wagner.

The scope of the analysis will include the following:

- Definition of basic NNP requirements and needs
- Current funding sources and assigned resources
- Functional tasks performed within and for NNPO
- Capability matrix

INDEX TERMS

DoD-Department of Defense

DOE-Department of Energy

DoS-Department of Science

DHS-Department of Homeland Security

DTRA-Defense Threat Reduction Agency

EES-Energy and Engineering Sciences

NNP-Nuclear Nonproliferation Program

NNPO-Nuclear Nonproliferation Program Office

NSTD-Nuclear Science and Technology Division

ORNL-Oak Ridge National Laboratory

NST-Nuclear Security Technology

NIS-Nonproliferation and International Security

NI-Nonproliferation Implementation

NMDC-Nuclear Material Detection and Characterization

SG-Safeguards

TT-Transportation Technologies

NSL-Nonproliferation Systems and Logistics

Program Description

The Oak Ridge National Laboratory (ORNL) Nuclear Nonproliferation Programs (NNP) develop, coordinate, and assist in implementing domestic and international policy aimed at reducing threats—internal and external—to the United States from weapons of mass destruction (WMD). The primary focus is reducing the proliferation of nuclear materials and nuclear weapons and radiological dispersal devices (RDD). Through its nonproliferation programs, the ORNL NNP is a primary contributor to policy efforts to detect, prevent, and reverse the proliferation of WMD and RDD. The NNP also supports a range of activities related to national security, spanning research and development activities through technology deployment and technical assessments.

Project Approach

Many of the tools applied to manufacturing can be used to complete an organizational analysis. The nature of these technical tools allows the functional analysis to be more concrete and less subjective than many of the tools commonly applied during organizational change. Although these tools can be extremely useful, they often need to be altered in order to apply to a non-manufacturing related problem. The DMAIC Problem-Solving Method is often useful in such circumstances, as it is more of a general approach that allows applicable tools to be applied in various stages. It is frequently referred to as the "basic Six Sigma roadmap". The name DMAIC represents the five major steps involved in the method: Design, Measure, Analyze, Improve, and Control.

Define

Clarifying Project Goals through Interviews

In order to clearly define the goals of the project, interviews were conducted with four of the top five managers of the NNP: 1) Mike Ehinger (Senior Research and Development Program Manager), 2) Teressa McKinney (NNP Operations Manager), 3) David Lambert (NNP Deputy Director for Program Management), and 4) Sharon Wagner (Nonproliferation Systems and Logistics). Due to the demanding travel schedule and the nature of his position, an interview was not scheduled with the Program Director, Larry Satkowiak. The four initial interviews provided a foundation for insight into the organizational structure of the program, the responsibilities of the interviewees, and the functional analysis objectives and deliverables.

The Survey

In an effort to conduct a satisfactory functional analysis of the NNP, it was imperative that the majority of the employees participate. Approximately 180 employees were informed about the analysis to be conducted over a period of three to six months. At first, all 180 of these interviews were to be conducted face-to-face. Based on the length of time it took to conduct the first four interviews, it was obvious that, given the time constraint, there would not be enough time to interview a significant sample of employees face-to-face. The interviews therefore, needed to be conducted in a way that would be time-sufficient, unbiased, and convenient for all involved. An online survey was determined as the best alternative to face-to-face interviews, due to its high accessibility and user friendly nature.

A large amount of introductory data mining and collection is required to determine what specific data will be needed in order to complete a functional analysis. In an "organizational system" very little numerical data is readily available. Furthermore, employees' comments must be taken with a grain of salt, as their answers are often biased. To ensure that you are not obtaining prejudiced information it is not a good idea to take information from within the organization at face value without comparing among employees. Our first step was to further define the project goals determined from the initial interviews with management.

As the managers had expressed their goal to hire four or five additional employees to help organize the program more efficiently, the job descriptions for these positions needed to be determined. Additionally, managers expressed the need for some kind of information management system to better represent their employees' knowledge and expertise to their potential and existing customers; implying that the data needed to be collected in a manner that allowed for easy conversion to a database or an alternative information management system.

Organizational Structure

One of the most common problems identified in the interviews was the complexity of the organizational structure. In order to address the perceived complexity, the existing organizational structure had to be defined. As it was extremely difficult to understand the existing structure, management's concern with the existing arrangement was reinforced. The organizational structure of the NNP program is defined as illustrated in the organizational chart below:

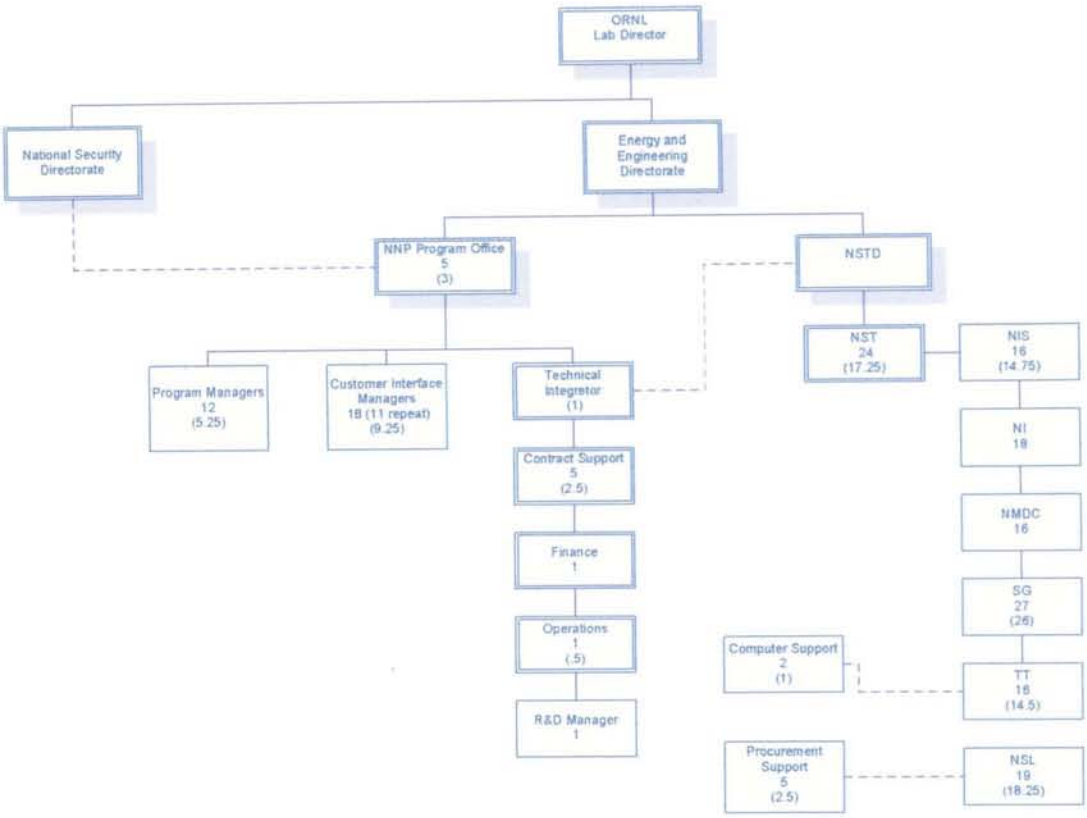


Figure 1: NNP Organizational Chart

The largest and most obvious concern is the "double duty" of the members in the NSTD and the NNP. The number below the division/manager name is the number of employees listed in that function and the number in parentheses is adjusted for "double duties." Not only do they have a manager for the program (Alex Reidy), they also have a manager within the NSTD (Jim Rushton). It was confirmed that although the majority of the tasks are submitted through Alex Reidy, the evaluations are completed by Jim Ruston. The arrangement does not allow for proper assessment of employees' capabilities and it does not provide the organization with a good record of what types of

employee expertise they are placing in positions to fill project teams to meet customer deliverables.

In order to define the system's day-to-day functionality, information data was gathered and exported about each of the employees within the NNP through an online survey as mentioned above. It was determined that it was important to define the job, expertise, projects, and tasks for each individual and to understand how their abilities fit within the program. An initial questionnaire was drafted and revised numerous times in order to create a non-biased survey. In addition, questions were added to quantify some responses. After creation, the survey was brought to the project lead and one of the program managers to review and make final revisions.

In order to get the survey up and running, it was necessary to meet with a survey consultant numerous times. Before the survey was disseminated, the survey was tested for proper operation. The survey was also tested by the project lead and additional recommendations were made. A notice was dispersed by the program director, describing the purpose of the survey and asking for all employees to complete the survey. The survey was enabled and employees began filling out the survey. Numerous reminders and some more forceful emails from the director were sent out to the employees in order to obtain the largest possible sample. The responses were exported and the data was categorized to allow for easier interpretation. This helped define individuals by their departments, job titles, main job tasks, etc.

Measure

Creating the Survey

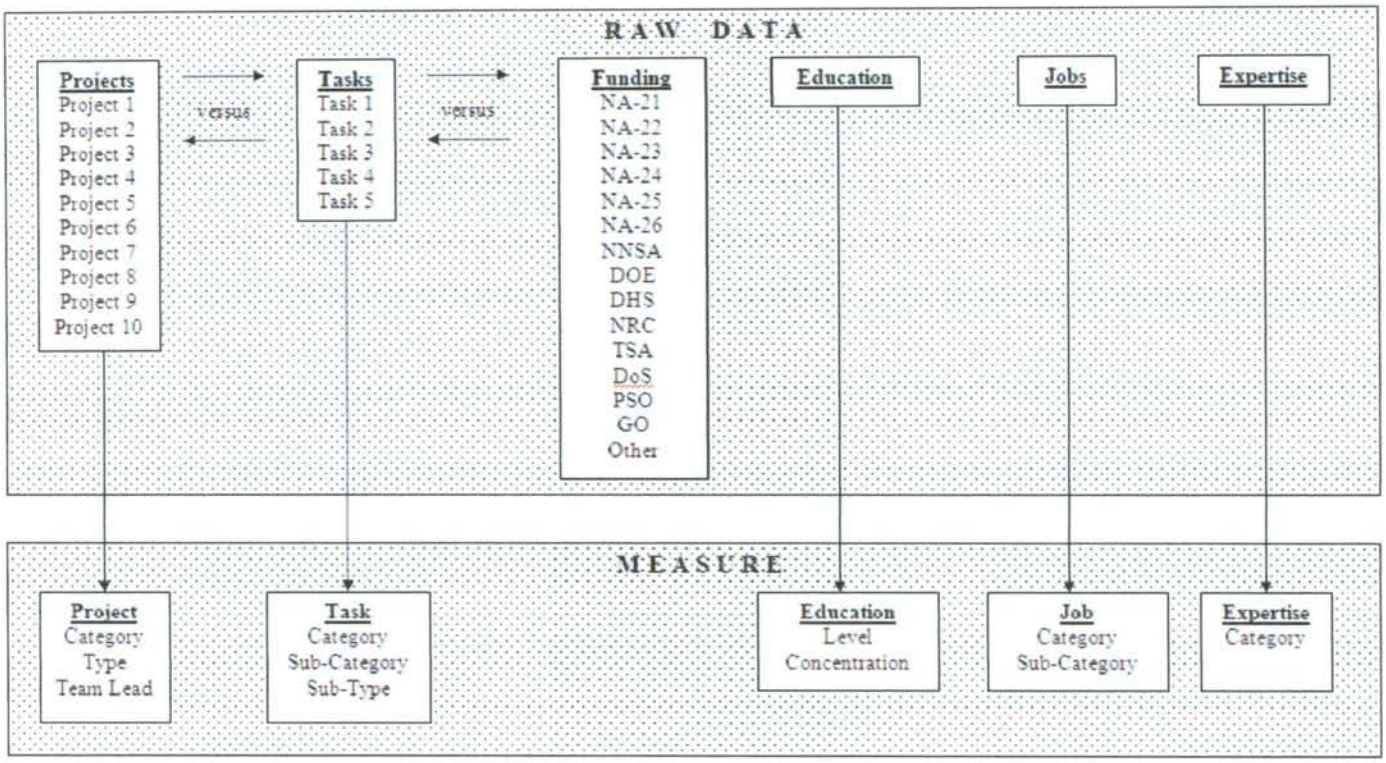
Before structuring the survey, a list of questions was formulated to the objectives of the study. These questions were created with the help of Sharon Wagner and David Lambert to ensure they represented the final output expected from the analysis. An Example of the survey questions are in Appendix I. Once the questions were approved, the survey was constructed. It took several days because creating the survey involved taking extra courses provided by the Statistics Department of the university. After an understanding of the software was achieved, several meetings with a professional statistician were set up to build the virtual survey.

Collecting the Data

Once the survey was completed, several tests were run to ensure that the survey was user-friendly and suitable. The employees from the NNP department were contacted with their password for entering the survey. A link was sent to their email addresses to direct each employee to the survey site. Notifications about the survey stressed the importance of the survey to further promote the NNP, and the ways that the employees might be benefited by the project success. Over the next few weeks, the data was monitored and reminders were sent to individuals to stress the importance of the survey and obtaining a representative sample.

The results were exported into an excel file to allow for better organization and the use of filters to understand the data. Once the raw data was compiled, it was sorted onto various spreadsheets based on the response. Each response was then categorized

and compared in order to find similarities in data and categories. The categories created and used to sort data are listed in Appendix II and the raw data and corresponding measures are in the diagram below. The current status for respondents of the survey is 96 completed, 30 currently taking, and 23 yet to take the survey.



Analyze

Initial Analysis

Once all of the data was exported and categorized, an initial analysis was done to identify where delays in receiving information originate. This is done by creating a Pareto Chart the categorized delays (it was an open ended question) to identify where most of the delays occur and then using the same task categories in categorizing delays. According to Figures 2, the delays are most common in the task categories of contracts and financial. It can be concluded that these areas will require further investigation to identify potential improvements.

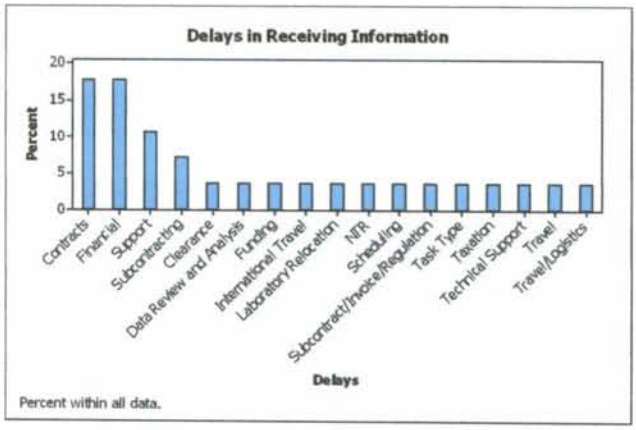


Figure 2. Delays in Receiving Information vs. Task Category

Analysis of funding is useful to identify the groups that bring in the most money, as well as determining the most significant contributors to the program's success. The following pie chart below shows that the most significant contributor is NA-25 followed

by NA-24. The group in the NSTD that brings in the most funding is the NSL (Nonproliferation Systems and Logistics).

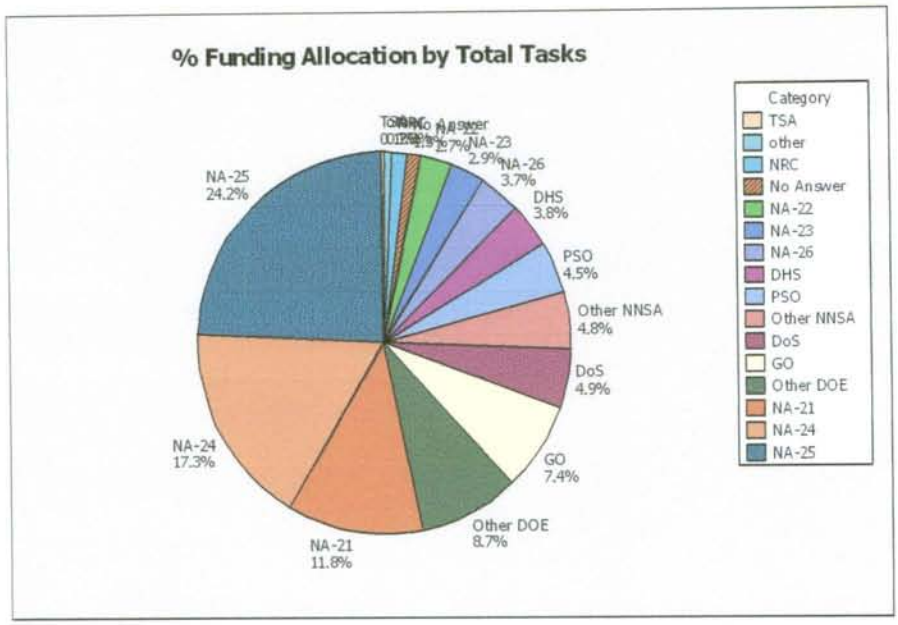


Figure 3. Primary Funding Sources (Allocation)

Similar charts were done to determine the primary funding sources most significant within each particular NSTD group and which task category is associated with the largest amount of funding (some of these charts are shown in Appendix III).

Communications Analysis

One of the primary goals of this study was to analyze the communication with the NNP. The capability and communication grid can be a very good tool to turn the qualitative opinion into a quantitative communication data. After exporting the results of the survey, the qualitative data is turned into a matrix where the worst case answer to each question is given the value of one and the best case answer is given a value of 5. After doing this, it is very easy to analyze the feelings of the NNP using an average and

standard deviation. This approach can then be used for each individual NSTD group in order to pinpoint which groups are having a problem with communication.

The initial analysis showed that the NNP employee feel that the biggest lack in communication is making employees aware of opportunities outside the program but within ORNL. The average response to this question was a 2.8 (as compared with the normal 3.5-4.0 that other questions received) and it had a high standard deviation. This means that the program as a whole feels that they are unaware of opportunities but there are a significant amount that feel otherwise. It can be seen below that biggest contributor to this lack of communication is ISG, NI, and SG groups. It can also be seen that NNP and MMDC should focus their attention to communication problems elsewhere.

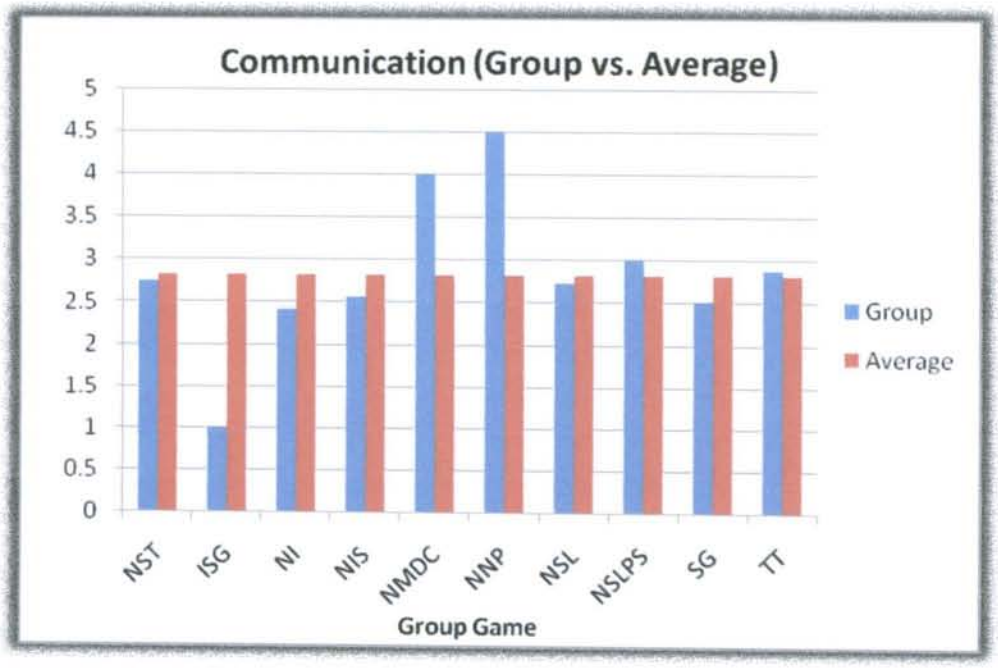


Figure 4. Delays in Receiving Information vs. Task Category

Queuing Model Analysis

When searching for the best tool to analyze the organizational flow of data between departments, there are several things to take into consideration. The first item of consideration is that Nuclear Nonproliferation Program employees take pride in the amount of funding they receive and the funding budget is a factor in determining whether the NNP is acquiring more projects and thus increasing its customer base and increasing its longevity as a government organization. The more projects that the NNP can finish in a given year the more funding and projects they will receive the next year. Also, a good metric for the performance and the speed of project completion is the amount of requests of employees that can be completed per unit time. Thirdly, this program is in a service industry. It is unlike most service industries in that a slow service rate will not necessarily make the requests leave the system like customer requests at McDonald's. A slow flow time of requests decreases the time that can be spent on other funding projects. In general, a request is going to come into the system, get processed, and then leave the system. With this basic fact in mind, it is clear that to analyze this request data we need to use tools from Operations Research, more specifically Queuing Theory.

Queuing Theory applies if we consider the organization a system with multiple servers and infinite queues. Since we cannot assume that our data follows a specific distribution, it is necessary to use Little's Law as the basis to find the flow time of the system and assume a standard normal distribution. Little's Law states:

$$FT = WIP/\lambda$$

The WIP is the average work in process divided by the arrival rate (λ) to find the average Flow Time. Several inferences need to be interpreted from the "attribute" survey

results. The total amount of main tasks done by employees by category is assumed to be the total percent time spent on tasks in that task category for the organization forming task request types and this is then converted into an arrival rate for employee requests.

The arrival rate per day for each type of task category is found by multiplying the percentage of each task category in an NSTD group by the total number of requests for that group. For example, to find the financial requests per day in the NST group:

$$\lambda = 6.5\ \% * 75 \text{ Requests/day} = 4.7 \text{ Requests/Day}$$

The next step is to calculate the average WIP. However, in order to calculate the average WIP several other attributes of the process must be gathered. The number of servers (S) is calculated by simply adding up the number of employees in each NSTD group. If a person happens to belong to two different NSTD group, it is assumed that they divide up their time evenly between groups. This means that if a person is in four different groups that only 0.25 of that person will be considered available to work on requests. In our example of the financial requests of the NST group, there is only one person available for that type of request. We also assume that a person has 450min (7.5 hrs) of available time per day. With this assumption the average service rate can be calculated

$$\text{Service rate } (\mu) = \frac{1}{t_s}$$

where t_s = estimated average service time in days

In the NST example, the service rate (μ) is equal to 1/(40/450) or 11.25. Once we have found S, μ, and λ, we can apply the Queuing Theory formulas to find the other important attributes of our request data. Note that $CV_{(A)}$ and $CV_{(B)}$ are the standard deviation of the

inter-arrival and service times respectively. They are both assumed to be one to account for randomness and a large variation.

The Average Time in Queue (L_q) = $\frac{p \wedge \sqrt{2(S+1)}}{1-p} * \frac{CV_{(A)} \wedge 2 + CV_{(B)} \wedge 2}{2}$

Average Waiting Time (W_q) = $\frac{L_q}{\lambda}$

Average Requests Simultaneously Filled (L_s) = p*S

Average Number in System (L) = $L_q + S\mu$

Average Time in System (W or FT) = $\frac{L}{\lambda}$

Probability of delay (P(t)) = $S\mu - \lambda$

Probability of no delay (P(0)) = 1- P(t)

Standard deviation of Waiting Time (σ) = $W_q\sqrt{\frac{2-p(t)}{p(t)}}$

Standard Deviation of Time in System (σ_s) = $\sqrt{\sigma^2 + (\frac{1}{\mu})^2}$

Worst Case Flow Time ("WC"FT) = FT + 3(σ_s)

The table below summarizes the attributes of the financial requests for the NST group:

Attribute Name	Attribute	Value
Number of Servers	S	1
Arrival Rate	λ	4.59
Service Rate	μ	11.25
Utilization	P	.41
Average Time in Queue	L_q	0.28
Average Waiting Time	W_q	0.06
Average Requests Simultaneously Filled	L_S	0.41
Average Number in System	L	0.69
Average Time in System	FT	0.15
Probability of delay	P(t)	0.41
Probability of no delay	P(0)	0.59
Standard deviation of Waiting Time	σ	0.12
Standard Deviation of Time in System	σ_s	0.15
Worst Case Flow Time	"WC"FT	0.6

At first glance, it appears that this section of NST is under-utilized. It is good thing that there is almost a 60% chance that if a request comes through this group that it

will be immediately attended to. However, this employee is only utilized 41% of the time meaning that more than half of the time he comes to work he is being paid to do nothing. As a result of this person's light workload, the Worst Case Flow Time is only 0.6 days or 4.5 hours. This mean that 99.7% of the requests made to this server will be completed within 4.5 hours.

There are some disadvantages to classic queuing theory. It is often too mathematically restrictive to be able to model all real-world situations exactly. This restriction arises because the underlying assumptions of the theory do not always hold in the real world. For example; the mathematical model presented in this project assumes an infinite number of requests, or queue capacity, or no bounds on inter-arrival or service times, when it is quite apparent that these bounds must exist in reality. Often, although the bounds do exist, they can be safely ignored because the differences between the real-world and theory is not statistically significant, as the probability that such boundary situations might occur is remote compared to the expected normal situation.

Current Flow Analysis

To complete the quantitative analysis of the organizational structure using queuing theory, the process flow for the current organizational structure is analyzed and then revised to increase employee productivity. The goal of the analysis is to utilize employees more efficiently to do the same amount of work in less time and thus increase the amount of new work the NNP can undertake. The current flow is illustrated in Appendix IV and can be defined as "the flow of employee requests as the organization functions today". The general assumption is that five requests are received per person

each day. Five requests per day was chosen as there are five main tasks identified in the survey, and these are most likely the most time consuming activities. Coincidentally, as there are 178 people within the program, there will be 890 total requests per day. However, these requests will be divided among the departments, managers, and divisions of the NNP. The arrival rates for each group were found by multiplying the daily requests by the percent of time spent on each task category (found in the Pareto Chart shown in Figure 5).

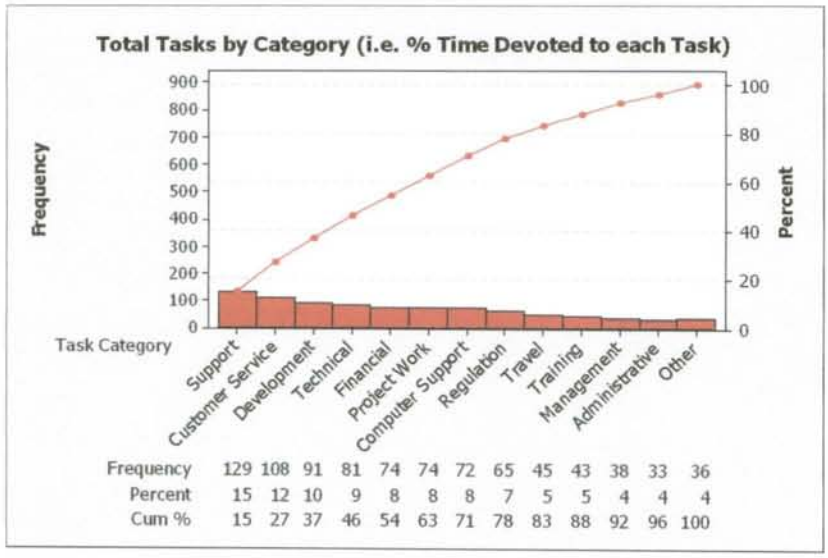


Figure 5. Percent of Time Spent on Each Task Category

The total number of tasks within each group is then pulled from the chart shown in Figure 6 and it is used to find the percent of tasks within each NSTD group. Then the percent of tasks within each group by task category is multiplied by the total requests arriving for the particular task category to find the arrival rates for each group by task category. Table 1 is the data used to calculate the arrival rates for type of request for each NSTD group (multiply Requests/Day column buy Percent tasks by NSTD group).

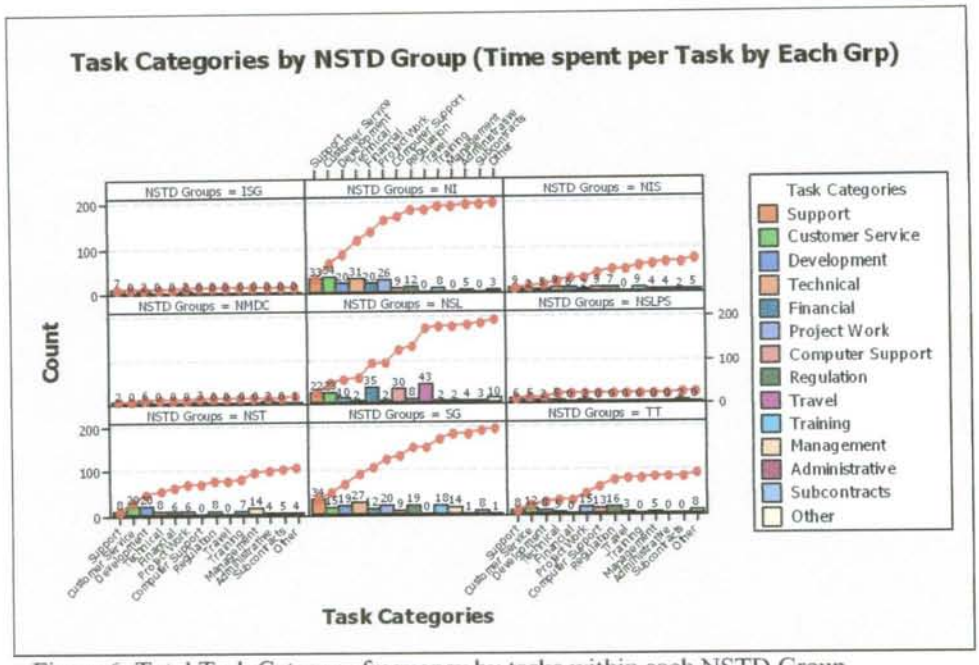


Figure 6. Total Task Category frequency by tasks within each NSTD Group

Table 1. Percentage of Tasks per NSTD Group

			Percentage of Tasks per NSTD Group								
Employee Task Categories	**Percent Task Category All**	**Requests/Day**	**NST**	**NIS**	**NI**	**NMDC**	**SG**	**TT**	**NSL**	**ISG**	**NSLPS**
Support	14%	124.6	9.3%	5.6%	24.1%	1.9%	25.9%	7.4%	14.8%	5.6%	5.6%
Customer Service	12%	106.8	15.6%	6.7%	33.3%	0.0%	13.3%	11.1%	15.6%	0.0%	4.4%
Development	10%	89	9.4%	6.3%	31.3%	9.4%	21.9%	12.5%	3.1%	3.1%	3.1%
Technical	9%	80.1	11.8%	11.8%	32.4%	0.0%	32.4%	8.8%	0.0%	0.0%	2.9%
Financial	8%	71.2	6.5%	6.5%	22.6%	0.0%	19.4%	0.0%	45.2%	0.0%	0.0%
Project Work	8%	71.2	3.2%	3.2%	38.7%	0.0%	25.8%	12.9%	6.5%	3.2%	6.5%
Computer Support	8%	71.2	0.0%	10.0%	13.3%	0.0%	10.0%	16.7%	50.0%	0.0%	0.0%
Regulation	7%	62.3	14.8%	11.1%	14.8%	0.0%	25.9%	22.2%	11.1%	0.0%	0.0%
Travel	5%	44.5	0.0%	0.0%	0.0%	0.0%	0.0%	5.3%	94.7%	0.0%	0.0%
Training	5%	44.5	16.7%	9.1%	6.9%	0.0%	16.0%	0.0%	2.3%	0.0%	0.0%
Management	4%	35.6	31.3%	2.6%	0.0%	0.0%	15.4%	7.7%	2.6%	0.0%	0.0%
Administrative	3%	26.7	30.8%	7.7%	30.8%	0.0%	7.7%	0.0%	23.1%	0.0%	0.0%
Other	3%	26.7	6.3%	12.5%	0.0%	6.3%	12.5%	12.5%	43.8%	0.0%	6.3%

The numbers in Table 2 are the Arrivals per day for each NSTD group from the calculation above. For the analysis, the Employee Task Category is changed to the "Type of Request."

The arrival rates in Table 2 are combined to reflect the Current Organizational flow (Appendix IV). As the Flow diagram displays many functions are currently separated between NSTD groups. The combined arrival rates for the current organizational flow based on division and functionality by NSTD Group are summarized in the Table 3.

Table 2. Arrivals per day by Employee Task Category

Employee Task Categories	**Arrival Rates: Requests per Day per NSTD Group per Task Category**									
	NST	**NIS**	**NI**	**NMDC**	**SG**	**TT**	**NSL**	**ISG**	**NSLPS**	**Total**
Support	11.5	6.9	30.0	2.3	32.3	9.2	18.5	6.9	6.9	124.6
Customer Service	16.6	7.1	35.6	0.0	14.2	11.9	16.6	0.0	4.7	106.8
Development	8.3	5.6	27.8	8.3	19.5	11.1	2.8	2.8	2.8	89.0
Technical	9.4	9.4	25.9	0.0	25.9	7.1	0.0	0.0	2.4	80.1
Financial	4.6	4.6	16.1	0.0	13.8	0.0	32.2	0.0	0.0	71.2
Project Work	2.3	2.3	27.6	0.0	18.4	9.2	4.6	2.3	4.6	71.2
Computer Support	0.0	7.1	9.5	0.0	7.1	11.9	35.6	0.0	0.0	71.2
Regulation	9.2	6.9	9.2	0.0	16.2	13.8	6.9	0.0	0.0	62.3
Travel	0.0	0.0	0.0	0.0	0.0	2.3	42.2	0.0	0.0	44.5
Training	7.4	4.1	3.1	0.0	7.1	0.0	1.0	0.0	0.0	22.7
Management	11.1	0.9	0.0	0.0	5.5	2.7	0.9	0.0	0.0	21.2
Administrative	8.2	2.1	8.2	0.0	2.1	0.0	6.2	0.0	0.0	26.7
Other	1.7	3.3	0.0	1.7	3.3	3.3	11.7	0.0	1.7	26.7
	90.5	60.3	193.0	12.3	165.4	82.6	179.1	12.0	23.1	818.2

Table 3. Arrival Rates for Current Flow

Request Type	Arrival Rate: Requests /Day							
	NST	NIS	NI	NMDC	SG	TT	NSL	Total
Group Leaders/Operations								
Support	11.5	6.9	30.0	2.3	32.3	9.2	18.5	110.8
Technical	9.4	9.4	25.9	0.0	25.9	7.1	0.0	77.7
Project Work	2.3	2.3	27.6	0.0	18.4	9.2	4.6	64.3
Regulation	9.2	6.9	9.2	0.0	16.2	13.8	6.9	62.3
Training	7.4	4.1	3.1	0.0	7.1	0.0	1.0	22.7
Other	1.7	3.3	0.0	1.7	3.3	3.3	11.7	25.0
Development	8.3	5.6	27.8	8.3	19.5	11.1	2.8	83.4
Financial	4.6	4.6	16.1	0.0	13.8	0.0	32.2	71.2
Computer Support	0.0	7.1	9.5	0.0	7.1	11.9	35.6	71.2
Customer Service	16.6	7.1	35.6	0.0	14.2	11.9	16.6	102.1
% Program/CI Manager	14.0	6.0	30.1	0.0	12.0	10.0	14.0	86.2
% Contract Support	2.6	1.1	5.5	0.0	2.2	1.8	2.6	15.9
Management and Admin	19.3	3.0	8.2	0.0	7.5	2.7	7.1	47.9
% Program Office	12.1	1.9	5.1	0.0	4.7	1.7	4.4	29.9
% TI, CFO, R&DD	2.4	0.4	1.0	0.0	0.9	0.3	0.9	6.0
Travel	0.0	0.0	0.0	0.0	0.0	2.3	42.2	44.5
	121.6	69.7	234.7	12.3	185.2	96.5	201.0	783.1

Along with the arrival rates, and service times, the utilization is found as an indicator of where process flows may be improved and the number of servers (employees in each department) can be combined. Flow times for the number of days to complete a request on employees are determined after calculating a flow time for each department using the arrival rate, servers, and service rate for that department. The service time is calculated by finding the total load on employees by multiplying each type of request by the service time and then dividing the total load by the number of arrivals. The service rate is one over the service time. The resulting flow times, standard deviations, and worst case flow times for each request path are calculated using the queuing theory calculations discussed previously in an excel template. The flow times, standard

deviations, and worst case flow times for the CURRENT Flow are displayed in the summary table shown below in Figure 7:

NST	Nuclar Security Technologies
NIS	Nonproliferation and International Security
NI	Nonproliferation Implementation
NMDC	Nuclear Material Detection and Characterization
SG	Safeguards
TT	Transportation Technologies
NSL	Nonproliferation Systems
F	Finance
CS	Computer Support
R&D	Research and Development

	CURRENT FLOW FINAL RESULTS				
		AVG FT	STD (σ)	WC FT	
NST	Path NST F	3.53	1.25	7.27	days
	Path NST CS	2.99	1.08	6.22	days
	Path NST R&D	3.98	1.38	8.11	days
NIS	Path NIS F	3.53	1.25	7.28	days
	Path NIS CS	3.07	1.10	6.38	days
	Path NIS R&D	3.61	1.26	7.39	days
NI	Path NI F	26.27	17.84	73.80	days
	Path NI CS	21.32	16.01	71.77	days
	Path NI R&D	20.52	16.72	70.68	days
NMDC	Path NMDC F	6.29	3.19	15.86	days
	Path NMDC CS	2.93	1.07	6.14	days
	Path NMDC R&D	3.92	1.37	8.04	days
SG	Path SG F	4.24	1.49	8.70	days
	Path SG CS	3.08	1.11	6.40	days
	Path SG R&D	5.31	2.26	12.09	days
TT	Path TT F	6.12	3.18	15.65	days
	Path TT CS	2.82	1.05	5.96	days
	Path TT R&D	3.42	1.22	7.10	days
NSL	Path NSL F	6.08	3.20	15.67	days
	Path NSL CS	2.72	1.09	5.99	days
	Path NSL R&D	3.24	1.26	7.02	days
		Weighted Avg FT		8.64	
		Weighted Avg (σ)		5.56	
		Weighted Avg WC FT		25.33	

Figure 7. Current Flow Final Results

The flow time (FT) can be defined as the time for a daily task request to flow through the organization using path constraints of the original structure. There are 21 flow times for the current flow because there are 21 paths for an employee request. Each path is dependent on the NSTD group and the functionality of the organization. It can be seen that the there are many delays or bottlenecks which slow down the flow time of the current process, and that the flow time is fairly long. It was identified that NI has utilization greater than one indicated by the FT of 17 days, and that NSL Finance is also causes a large increase in FT. The main problem is that major functions that are normally considered departments in other organization are separated by NSTD group such as Finance, Travel, Development, and Computer support. The separation of functions

causes people to be overworked in some areas and underutilized in others. The overly complicated organizational structure implicates the need for simplification.

Improve

New Flow

In light of the analysis, it can be seen that the organizational structure needs to be revised. From the flow times, it is seen that a streamlined, less complicated flow would be beneficial. Furthermore, the removal of "bottleneck" processors such as NSL, NI, and combining the job of customer interface manager and program manager will increase the efficiency of the process. The "New Flow" can be defined as the flow of employee requests combining similar functions to centralize operations. The "New Flow" is illustrated in Appendix V. The model splits the flow into three critical paths: Safeguards and Security, Materials and Implementation, and Logistics and Transportation by combining the NSTD groups of SG, NSL, and NIS to form the Safeguards and Security Division. NI and NMDC are combined to form materials and implementation. TT and NSTD are combined to form the transportation and technology division. The NSTD groups were combined based on amount of funding, expertise in the group, and the type of requests processed. In addition the independent finance, development, travel, and computer support groups were combined since they perform the same duties but with varying amounts of arrivals. The paths in the New flow are decreased to 9 indicating a simplification of the possible paths for a request on employees entering the system. The simplified format decreases the amount of possible delays and greatly decreases worst case flow times. The following table summarizes the flow and all associated times:

NEW FLOW FINAL RESULTS				
	AVG FT	STD (σ)	WC FT	
Path SS F	2.52	1.05	5.68	days
Path SS CS	1.86	0.82	4.33	days
Path SS R&D	2.50	1.05	5.66	days
Path MI F	2.54	1.06	5.71	days
Path MI CS	1.88	0.82	4.35	days
Path MI R&D	2.52	1.06	5.69	days
Path LT F	2.53	1.05	5.68	days
Path LT CS	1.87	0.82	4.33	days
Path LT R&D	2.51	1.05	5.67	days
	Weighted Avg FT		2.31	
	Weighted Avg STD (σ)		0.98	
	Weighted Avg WC FT		5.24	

SS	Safeguards and Security
MI	Materials and Implementation
LT	Logistics and Transportation
F	Finance
CS	Computer Support
R&D	Research and Development

Figure 8. New Flow Final Results

By reviewing Figure 8, it can be seen that the change in flow leads to large improvements in flow time. The weighted average flow time decreases from 8.64 days to 2.31 days with the change in organizational structure.

Portfolio Flow

There are additional risks in changing the management structure in addition to just combining business functions. Therefore, another redesigned flow was created to ensure that the best solution is obtained and to provide a solution to the management goal of employing portfolio managers to bring in additional funding. This flow is called the "Portfolio Flow". It can be defined as "the flow of employee requests combining similar functions to centralize operations and changing the management structure to facilitate project completion and customer contract deliverables". The portfolio flow is illustrated visually in Appendix VI. The organizational structure is based on the focus of the five new portfolio manager positions that will be introduced to the program. Each of the portfolio managers will be responsible for their group/focus, especially concerning the processing of requests and the promotion of their area of focus with the customers. The portfolio managers are created while eliminating the Finance director, Development

director, and NSTD group leads, and giving them a separate title and providing them with more support. Some people could be added in the portfolio position due to the decrease in work needed within the groups. The Finance and Development functions can bypass the NNP operations flow now that the portfolio manager can act as the coordinator for project deliverables and as the liaison from operations to Finance and Development. The portfolio flow's improvements are illustrated in Figure 9.

PORTFOLIO FLOW FINAL RESULTS				
	AVG FT	STD (σ)	WC FT	
Path Portfolio 1	1.20	0.48	2.64	days
Path Portfolio 2	1.22	0.48	2.67	days
Path Portfolio 3	1.22	0.48	2.66	days
Path Portfolio 4 F	1.29	0.52	2.87	days
Path Portfolio 5 R&D	1.28	0.52	2.85	days
	Weighted Avg FT		1.21	
	Weighted Avg STD (σ)		0.48	
	Weighted Avg WC FT		2.66	

Figure 9. Portfolio Flow Final Results

From the table shown in Figure 9, it can be concluded that the Portfolio Flow is a great improvement of the current flow as the average weighted flow time decreases to 1.21 days. Therefore, from a functional perspective, this model would be recommended over the current and new flows.

Failure Modes and Effects Analysis

FMEA (failure modes effects analysis) is then done to identify risks that can occur along with the change in organizational structure. The severity, detection, and occurrence is determined based on the 1-10 rating scale. The risk score (RPN) is determined by multiplying the three ratings. The risks with the highest scores were

determined and they are the risks that will affect the cost/customer satisfaction most based on severity, detection, and occurrence. The FMEA table is shown below:

Table 4. FMEA Risk Analysis

Risk Analysis: FMEA										
	Risk Factor	**Effect on Operations**	**Severity**		**Occurrence**		**Design Controls**	**Detection**		**RPN**
1	Employees resistant to change	Employees are inefficient, ineffective, and can even be harmful	Very High	8	Low	2	Emphasize benefits of new organization	Moderately High	4	64
2	Conflict regarding management and leadership roles	Can cause miscommunication and discouraged employees	High	7	Low	2	Clearly define leadership roles	Moderately High	4	56
3	Idle and confused employees due to confusion regarding new tasks	Leads to low utilization and repetition of tasks	Low	5	Moderate	4	Define all tasks associated with jobs	Low	6	120
4	Confusion with information and communication flows/transfers	Delays or problems with information transfer	Low	5	High	7	Define communication channels	Low	6	210
5	Existing customers have to adjust to dealing with different contacts	Customer dissatisfaction and delays in information	Low	5	Moderate	4	Complete orientations to introduce existing customers to new contacts	Moderately High	4	80
6	Necessary tasks are not completed due to confusion regarding new responsibilities	Tasks are not always completed when required	Hazardous	9	Remote	1	Clarify job descriptions and responsibilities	High	3	27

From the risk analysis, it is concluded that the primary concern with the change in organizational structure is confusion concerning communication and information transfers, etc. This implies that with the change it would be extremely important to implement a control such as a communications plan and guidelines. The second risk which was found to be a concern is the lack of employee efficiency due to uncertainty regarding new tasks or responsibilities. Therefore, controls such as clear definitions of employees' routine tasks and responsibilities should be implemented at the time of the structural change.

Selecting Optimal Organizational Structure/Flow

In order to select the best method of redesign, it is important to summarize and compare each model to ensure the optimal end result. A summary of the three models is illustrated in the table 5, as well as the chart shown in Figure 10. The reduction shown is in reference to the Portfolio model, as it is determined to be the best model (largest reduction).

Table 5. Flow Model Summary

	Flow Type				
	Current	**New**	**Portfolio**	**Reduction**	
Weighted Avg. FT	8.64	2.31	1.21	7.43	days
Weighted Avg. WC FT (+3σ)	25.33	5.24	2.66	22.67	days
FT STD (σ)	7.10	5.69	2.67	4.43	days
Overall Worst WC FT	79.80	5.68	2.87	76.94	days
Division/ NSTD Group	Nuclear Implementation Operations and Finance	Logistics and Transportation Operations and Finance	Finance		
Overall Best WC FT	5.96	4.33	2.64	3.32	days
Division/ NSTD Group	Transportation Technologies Operations and Computer Support	Computer Support	Safeguards and Security		
Request Paths (Complexity of Organizational Structure)	21	9	5	16	paths
Requests Tied up in System (WIP) = FT/λ	476	127	67	409	requests
Requests Tied up in System (WC) (WIP) = FT/λ	1,395	289	147	1,249	requests

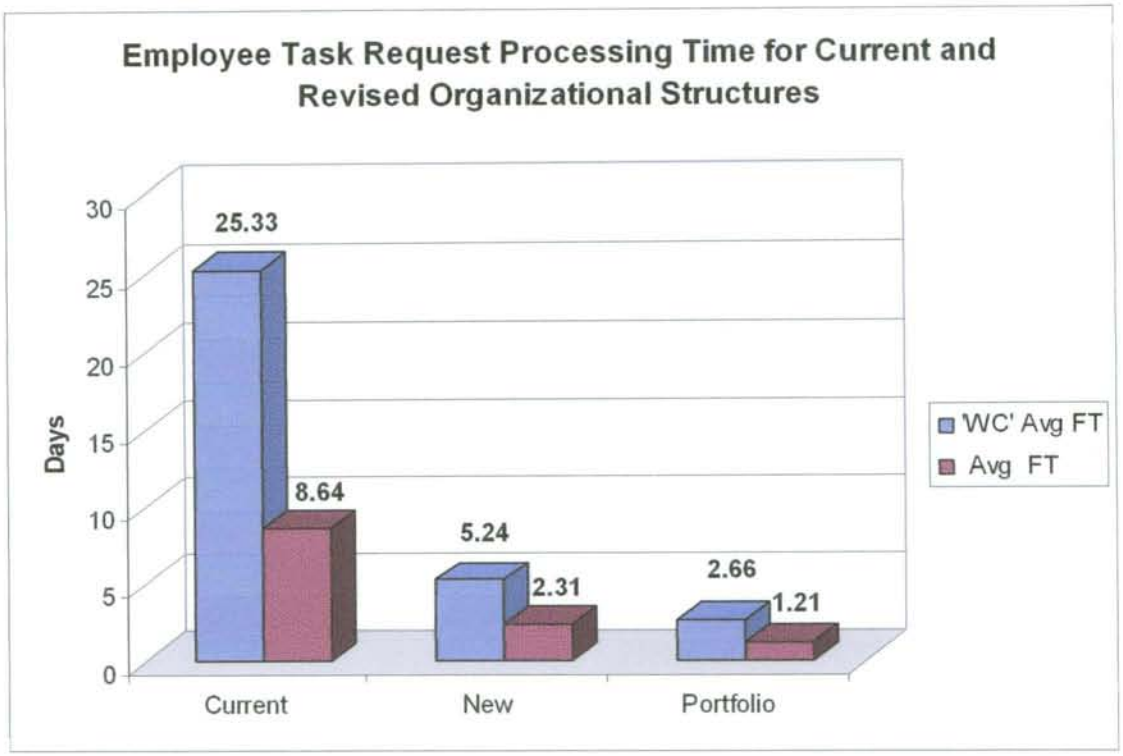


Figure 10. Comparison of Task Request Processing Times

The portfolio model is concluded to be the best model, not just due to the significant decrease in flow time, but also because of the decrease in variation of flow time as indicated by the reduced complexity of the organization structure (shown in decrease in request paths). The decrease in variation is also indicated the smaller delta between the the FT and the worst case flow time. Furthermore, the model also exhibits a significant decrease in work in process (WIP).

Finally, the portfolio flow determines the new suggested organizational flow below. The organization has been flattened and streamlined to increase the efficiency in which employee requests are processed when comparing flow times and when compared with the Current Org Chart in the Define section.

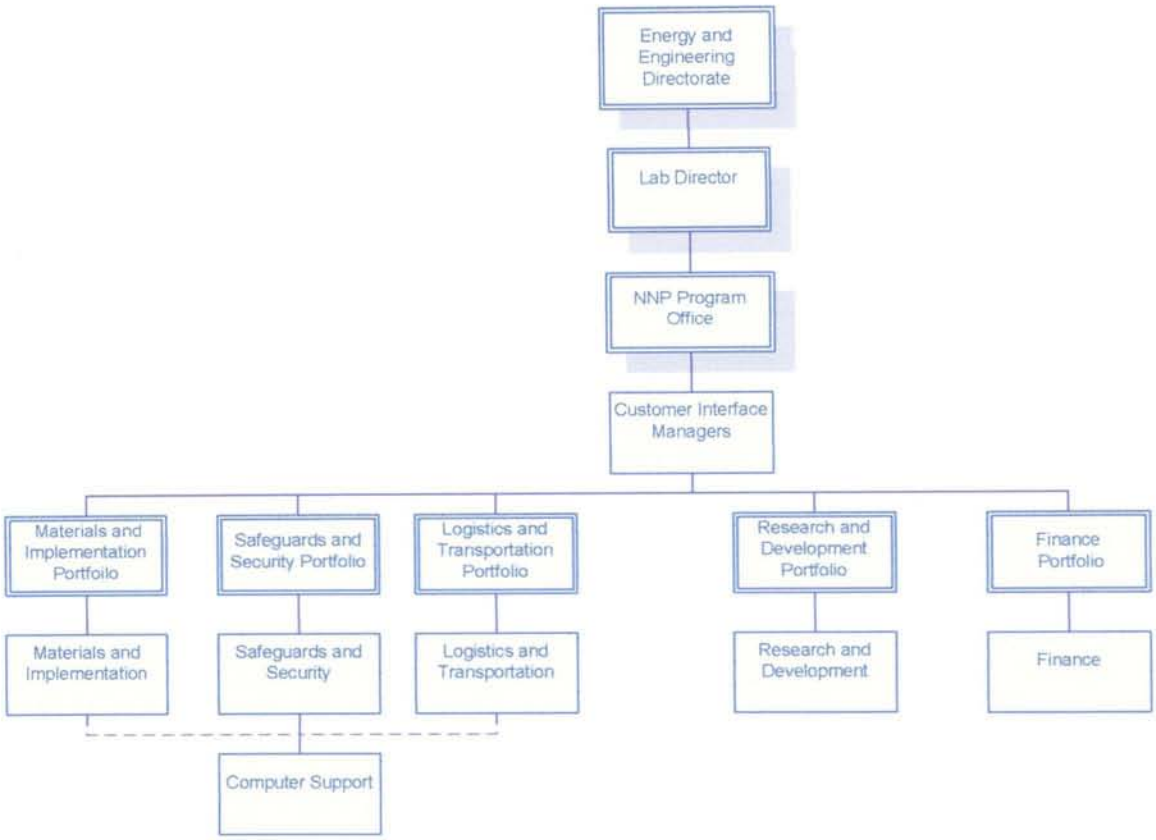


Figure 11: New Organizational Chart with Portfolio Managers

Financial Analysis and Improvement

The main goal of the NNP's new organizational structure is to increase the work taken on, not fire employees. NNP would like to do more work with the same amount of people in order to increase their funding budget. The increase in funding budget is important for the NNP because the higher the budget, the better they look and a "profit center" for the US Government. In addition, the Portfolio Managers in the new structure facilitate an increase in work flow. The table below summarizes the financial analysis comparing the current costs/finds versus those associated with the portfolio flow:

Table 6. Financial Analysis and Summary

Yearly Funding Dollar Budget for Projects	$297,297,775.57		Dollars
Hours of Available Employee Work Time (450 hrs/wk, 48 Weeks, 178 employees)	4,165,200		Hours
Funding Dollars allocated per Hour	$71.38		$/Hour
Current Number of Projects for FY 2007	127		Projects
Average Funding Dollars per Project per Year	$2,340,927.37		$/Project
	Maximum	Minimum	
Current WAvg Time to Process a Daily Employee Task Request	189.99	64.81	Hours/Request
New WAvg Time to Process a Daily Employ Task Request	19.95	9.11	Hours/Request
Decrease in Task Request Processing Time	170.04	55.71	Hours/Request
Average Request Rate per Day for Organization	55.1		Requests/Day
Average Total Requests per Year	18,514		Requests/Year
Increased Working Capacity in Hours	3,148,062.07	1,031,313.12	Hours/Year
Increase in Funding Dollar Capacity (i.e. Profit, because all overhead and employee count is unchanged)	$224,697,937.93	$73,611,614.72	Dollars
Number of New Projects Potentially Undertaken	96	31	Projects
% increase in Funding Capacity	76%	25%	Percent
Average increase In Funding Capacity	$149,154,776.33		Dollars
Average Number of New Projects Potentially Undertaken	64		Projects
Average % increase in Funding Capacity	50%		Percent
Reduction in WIP (Requests Tied up in System)	1,249	409	Requests
Increase in Capacity due to WIP Decrease	212,341.56	22,789.22	Hours
One-Time Capacity Increase Due to WIP Reduction	$15,156,216.90	$1,626,617.07	Dollars

Through the financial analysis, the increase in funding or funding capacity is greatly increased by the redesigned model. This conclusion is reinforced by the following chart:

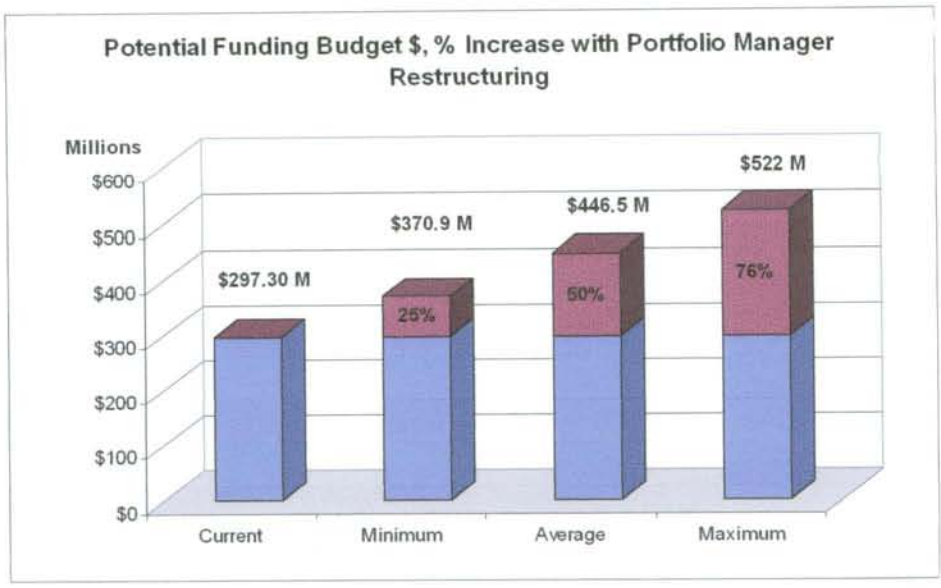


Figure 12. Potential Budget Funding Increase with Portfolio Flow

By looking at the potential increase in funding, the overall impact of the restructuring is depicted. Figure 12 displays how much of a difference a restructured flow can make on an organization.

Due to the intensity of the improvements, the Portfolio flow would be recommended as a redesigned organizational structure, even considering the potential risks involved.

Control

There are numerous tools and controls that can be implemented to ensure that the new organizational structure maintains proper operations and meets all customer wants and demands and that it maintains the expected and anticipated results of decreased demands on current employee time allowing for the organization to increase its funding base. Some initial organizational tools and definitions will serve as controls in a new

organizational structure. For example, the portfolio manager roles will themselves be controls, as they will monitor the function or area that they are responsible for, as well as the number of requests entering that "area".

As uncertainty regarding positions and task requirements is going to be a major concern for proper program functioning, clarification is required for proper redesign. Defining positions, responsibilities, and evaluative measures, will help to ensure that each employee is operating in an efficient way and is meeting all program goals (is not out of control). In addition, priorities for requests and communication paths ought to be defined in order to ensure that information is not lost or repeated. Currently, there are no definitions of jobs and formal requests for project team members based on expertise.

In addition, the current organizational structure was determined using the same number of people and in some areas, the restructuring decreased utilization. The utilization of each department will need to be analyzed before new positions are created or new people are hired because people may be candidate for a position within the organization thus the NNP can avoid increasing base costs with keeping employee utilization as a hiring tool.

Control charts can also be used to ensure that all measures are kept within acceptable limits. Historical data can be used to determine the limits for the current organizational flow. We decided that utilization of employees is a good indicator that request flow time will be increasing because the time the employees are working increases. The moving range chart of the current utilization is below indicating a range UCL of almost one which is almost 100% utilization. The current flows max limit will need to be less than 1.0 so it is set as 0.9 because 0.9 will still allow the proper flow of

requests and people from departments with lower utilization can be used to take on excess work. To maintain a balance of work in case other departments are overloaded, the lower control limit is set at 0.5. The I chart of the current flow is also below verifying the range of the data is correct.

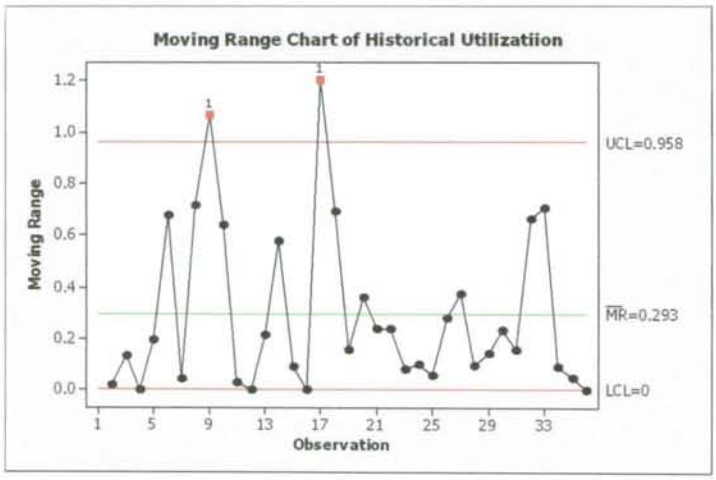


Figure 13. Moving Range Chart of Historical Utilization

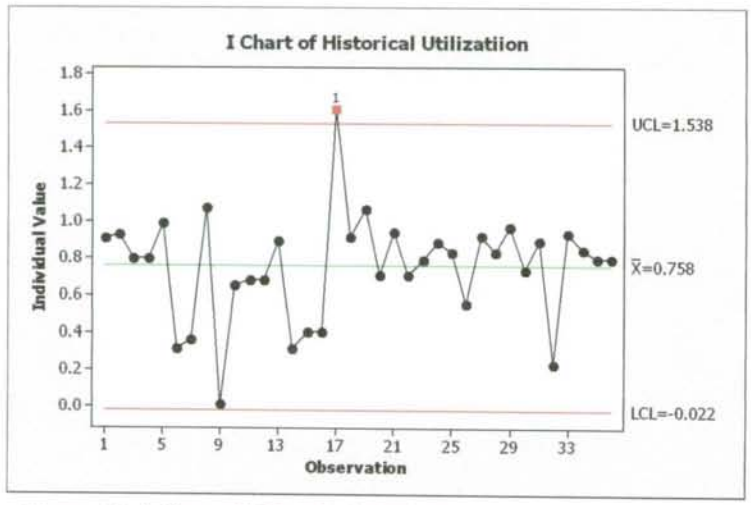


Figure 14. I Chart of Historical Utilization

The next set of control charts are the MR chart and I chart for the current utilization. Using the UCL and LCL from the historical data, the Range chart is plotted first. If the upper range is greater than 0.4 then the system is out of control because it is out of the range limit. The I chart shows the data for the current system is in control. The utilization data needs to be taken on a periodic schedule to determine if control of the new Portfolio Organizational Structure is maintained.

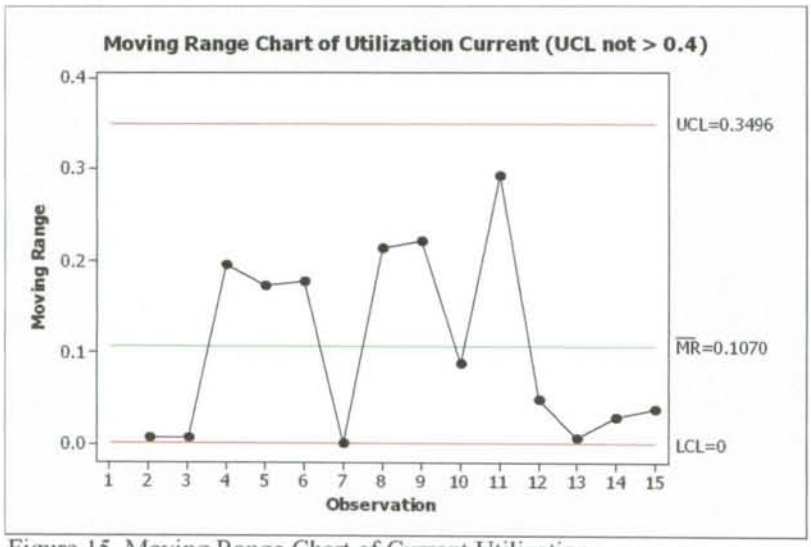


Figure 15. Moving Range Chart of Current Utilization

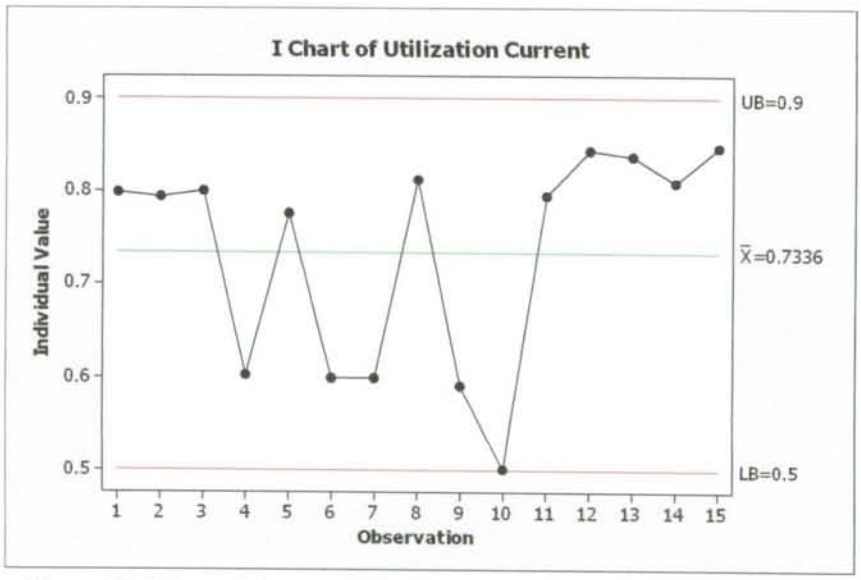
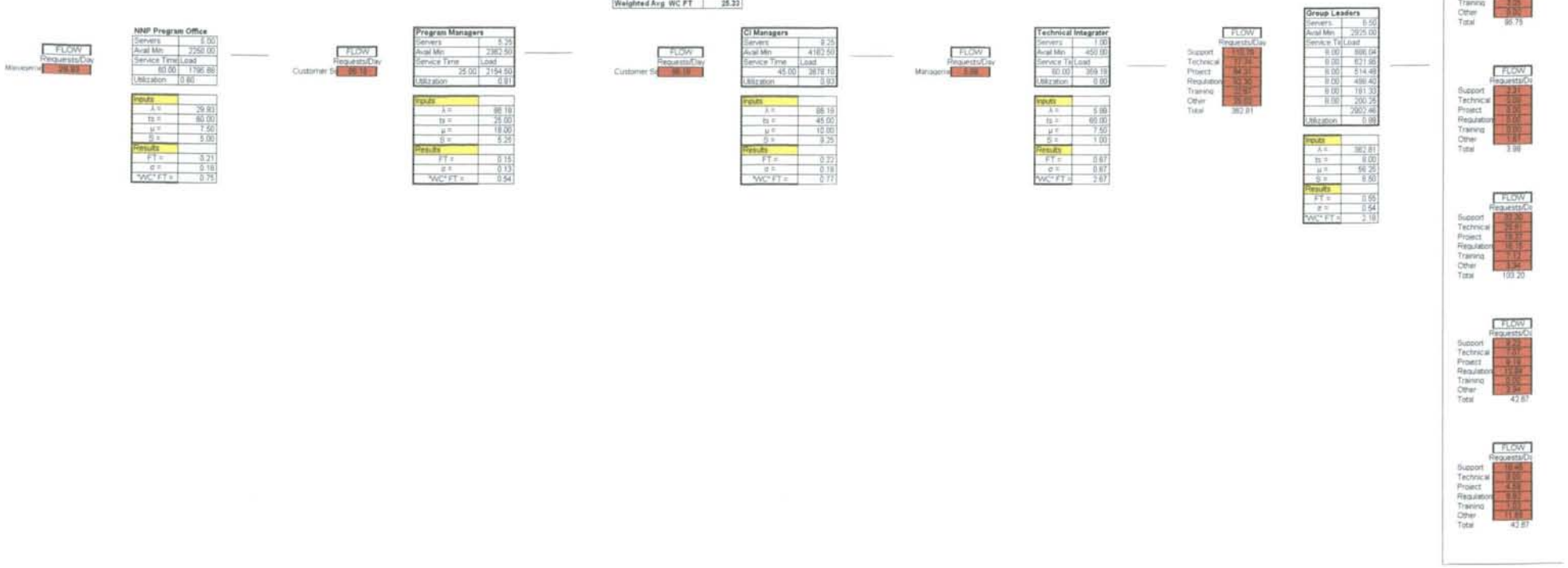


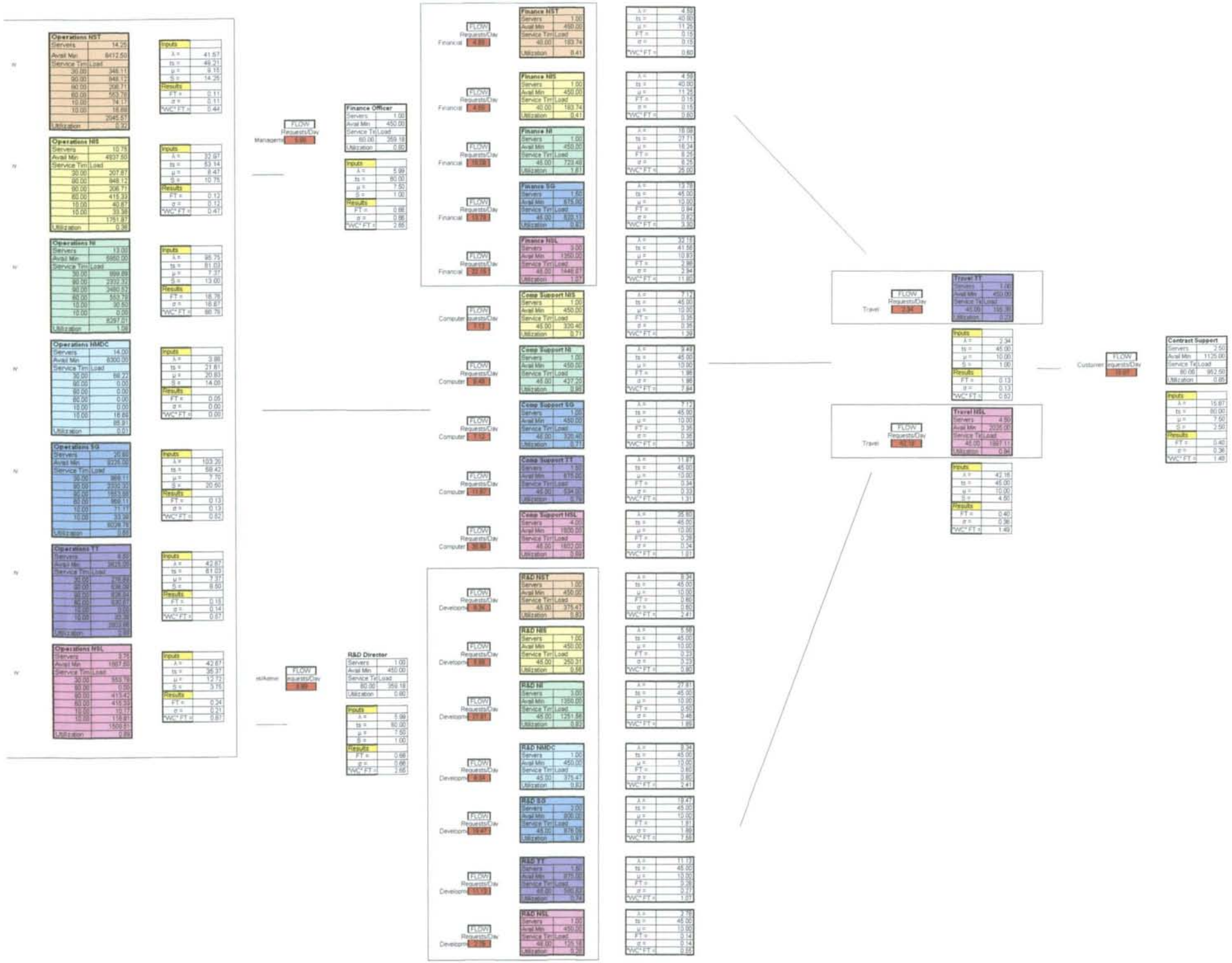
Figure 16. I Chart of Current Utilization

APPENDIX IV

NST	Nuclar Security Technologies
NIS	Nonproliferation and International Security
NI	Nonproliferation Implementation
NMDC	Nuclear Material Detection and Characterization
SG	Safeguards
TT	Transportation Technologies
NSL	Nonproliferation Systems
F	Finance
CS	Computer Support
R&D	Research and Development

CURRENT FLOW FINAL RESULTS					
		AVG FT	STD (σ)	WC FT	
NST	Path NST F	3.83	1.25	7.27	days
	Path NST CS	2.99	1.06	4.22	days
	Path NST R&D	3.98	1.39	8.11	days
NIS	Path NIS F	3.83	1.25	7.28	days
	Path NIS CS	3.07	1.10	4.38	days
	Path NIS R&D	3.81	1.26	7.39	days
NI	Path NI F	26.27	17.84	79.80	days
	Path NI CS	21.32	16.61	71.77	days
	Path NI R&D	20.53	16.73	70.66	days
NMDC	Path NMDC F	6.29	3.19	15.86	days
	Path NMDC CS	2.93	1.07	4.14	days
	Path NMDC R&D	3.93	1.37	8.04	days
SG	Path SG F	4.24	1.49	8.70	days
	Path SG CS	3.08	1.11	6.40	days
	Path SG R&D	5.31	2.20	12.09	days
TT	Path TT F	6.12	3.18	15.68	days
	Path TT CS	2.82	1.05	5.96	days
	Path TT R&D	3.42	1.22	7.10	days
NSL	Path NSL F	6.08	3.26	15.87	days
	Path NSL CS	2.72	1.09	5.99	days
	Path NSL R&D	3.24	1.26	7.02	days
	Weighted Avg FT			8.64	
	Weighted Avg. (σ)			5.86	
	Weighted Avg. WC FT			25.33	



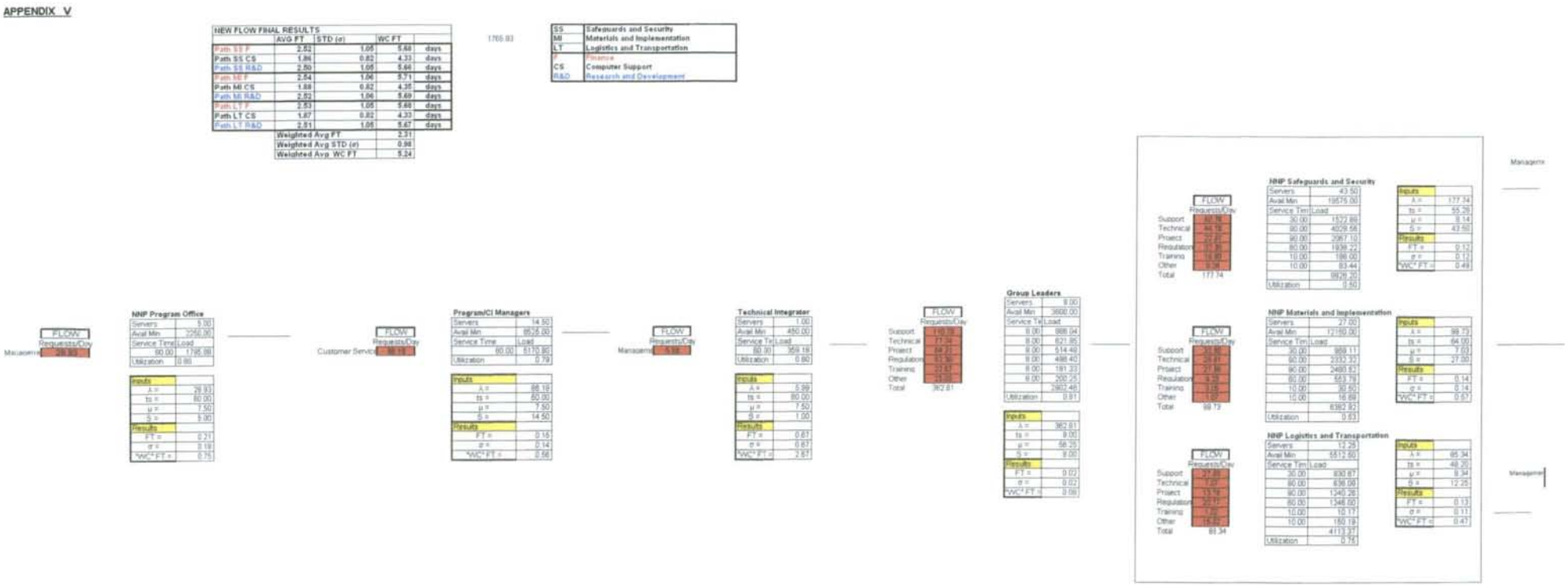

Operations NST
Operations NIS
Operations NI
Operations NMDC
Operations SG
Operations TT
Operations NSL
Finance Officer
R&D Director
Finance NST
Finance NIS
Finance NI
Finance SG
Finance NSL
Comp Support NIS
Comp Support NI
Comp Support SG
Comp Support TT
Comp Support NSL
R&D NST
R&D NIS
R&D NI
R&D NMDC
R&D SG
R&D TT
R&D NSL
Travel TT
Travel NSL
Contract Support
Financial
Computer
Developm
Customer
Inputs
Results
Utilization

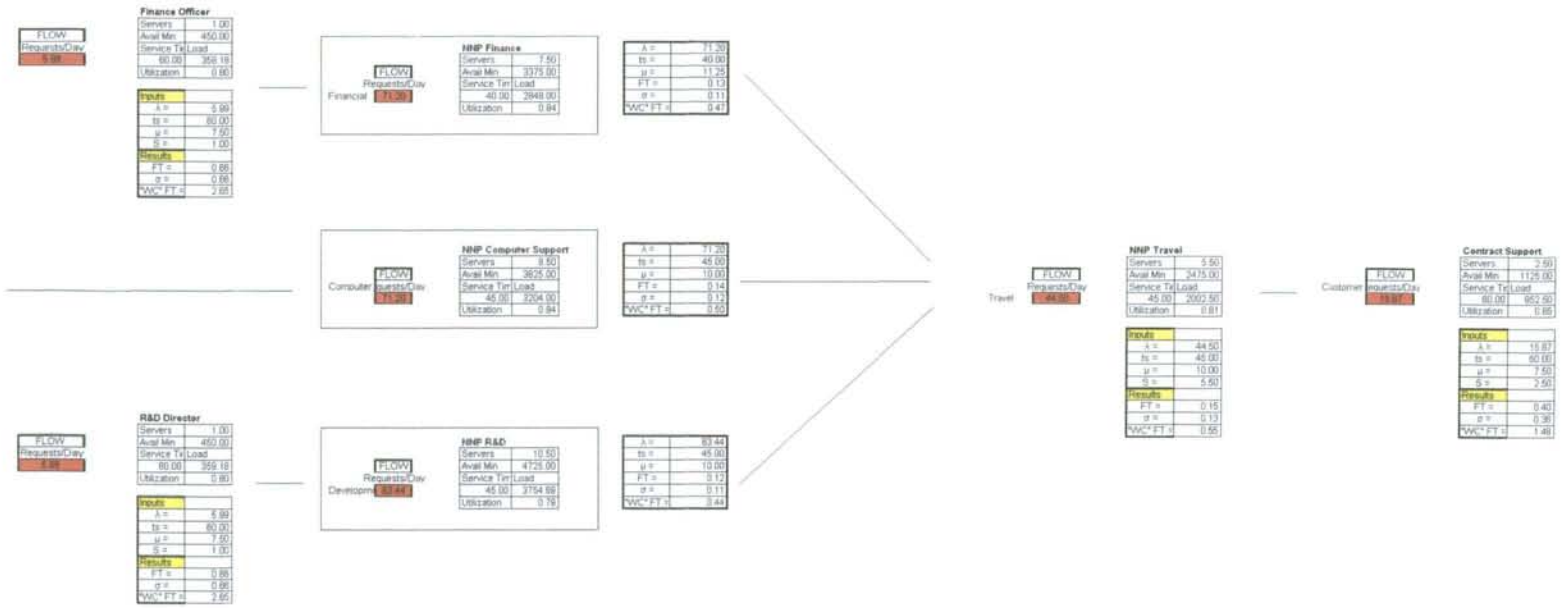
APPENDIX V

NEW FLOW FINAL RESULTS				
	AVG FT	STD (σ)	WC FT	
Path SS F	2.52	1.06	5.68	days
Path SS CS	1.86	0.82	4.33	days
Path SS R&D	2.50	1.06	5.66	days
Path MI F	2.54	1.06	5.71	days
Path MI CS	1.88	0.82	4.35	days
Path MI R&D	2.52	1.06	5.69	days
Path LT F	2.53	1.06	5.68	days
Path LT CS	1.87	0.82	4.33	days
Path LT R&D	2.51	1.06	5.67	days
Weighted Avg FT			2.31	
Weighted Avg STD (σ)			0.98	
Weighted Avg WC FT			5.24	

1766.83

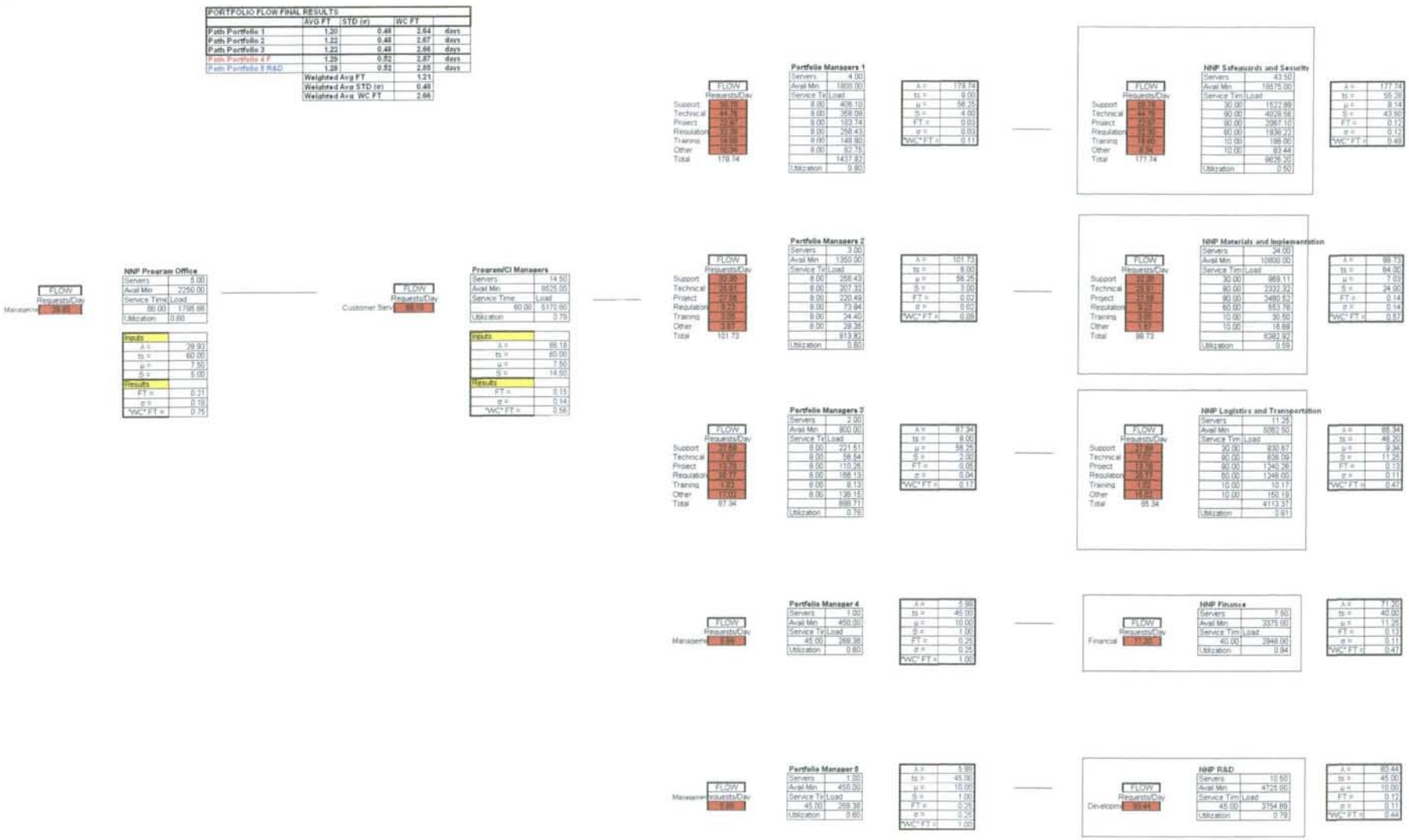
SS	Safeguards and Security
MI	Materials and Implementation
LT	Logistics and Transportation
F	Finance
CS	Computer Support
R&D	Research and Development

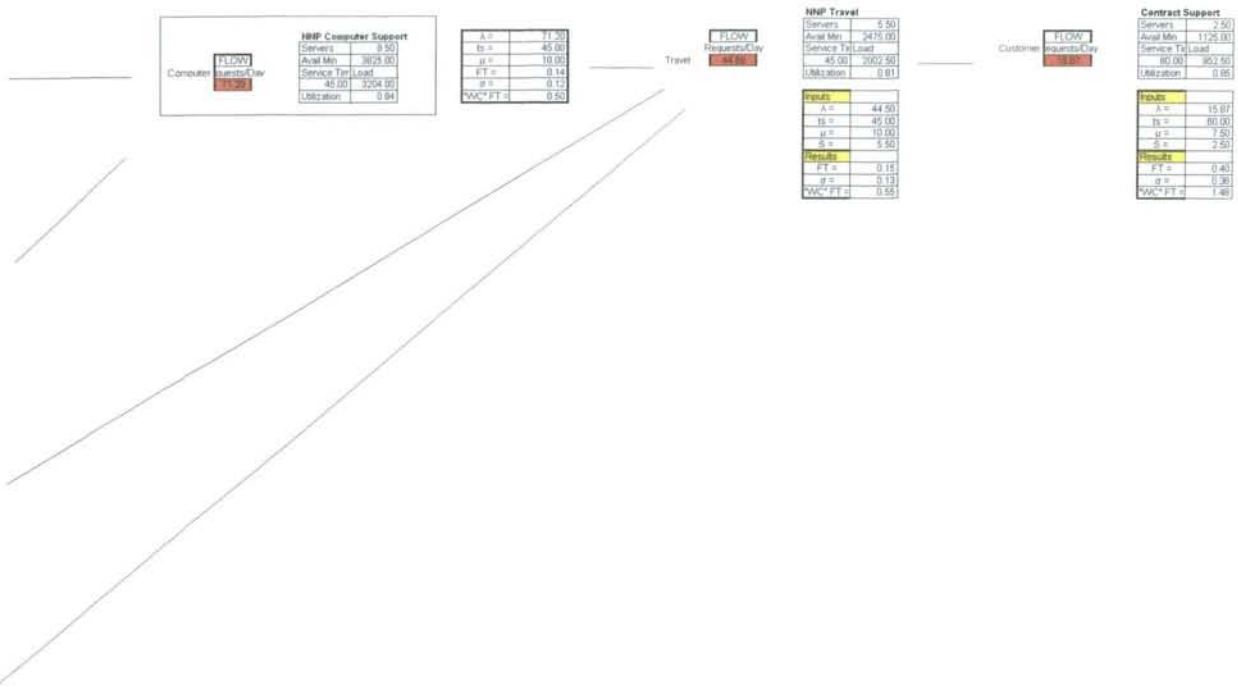



FLOW
Requests/Day
5.99
Finance Officer
Servers 1.00
Avail Min 450.00
Service Tir Load
60.00 359.18
Utilization 0.80
Inputs
λ = 5.99
ts = 60.00
μ = 7.50
S = 1.00
Results
FT = 0.88
σ = 0.66
WC FT = 2.65
FLOW
Requests/Day
Financial 71.20
NNP Finance
Servers 7.50
Avail Min 3375.00
Service Tir Load
40.00 2848.00
Utilization 0.84
λ = 71.20
ts = 40.00
μ = 11.25
FT = 0.13
σ = 0.11
WC FT = 0.47
FLOW
Requests/Day
Computer 71.20
NNP Computer Support
Servers 8.50
Avail Min 3825.00
Service Tir Load
45.00 3204.00
Utilization 0.84
λ = 71.20
ts = 45.00
μ = 10.00
FT = 0.14
σ = 0.12
WC FT = 0.50
FLOW
Requests/Day
5.99
R&D Director
Servers 1.00
Avail Min 450.00
Service Tir Load
60.00 359.18
Utilization 0.80
Inputs
λ = 5.99
ts = 60.00
μ = 7.50
S = 1.00
Results
FT = 0.88
σ = 0.66
WC FT = 2.65
FLOW
Requests/Day
Developme 83.44
NNP R&D
Servers 10.50
Avail Min 4725.00
Service Tir Load
45.00 3754.68
Utilization 0.79
λ = 83.44
ts = 45.00
μ = 10.00
FT = 0.12
σ = 0.11
WC FT = 3.44
Travel
FLOW
Requests/Day
44.50
NNP Travel
Servers 5.50
Avail Min 3475.00
Service Tir Load
45.00 2002.50
Utilization 0.81
Inputs
λ = 44.50
ts = 45.00
μ = 10.00
S = 5.50
Results
FT = 0.15
σ = 0.13
WC FT = 0.55
Customer
FLOW
Requests/Day
15.87
Contract Support
Servers 2.50
Avail Min 1125.00
Service Tir Load
60.00 952.50
Utilization 0.85
Inputs
λ = 15.87
ts = 60.00
μ = 7.50
S = 2.50
Results
FT = 0.40
σ = 0.36
WC FT = 1.48

APPENDIX VI

PORTFOLIO FLOW FINAL RESULTS				
	AVG FT	STD (σ)	WC FT	
Path Portfolio 1	1.20	0.48	2.64	days
Path Portfolio 2	1.22	0.48	2.67	days
Path Portfolio 3	1.22	0.48	2.66	days
Path Portfolio 4 F	1.29	0.52	2.87	days
Path Portfolio 5 R&D	1.28	0.52	2.85	days
	Weighted Avg FT		1.21	
	Weighted Avg STD (σ)		0.48	
	Weighted Avg. WC FT		2.66	




FLOW
Computer Requests/Day
71.59
NNP Computer Support
Servers 9.50
Avail Min 3825.00
Service Tim Load
45.00 3204.00
Utilization 0.84
λ = 71.59
ts = 45.00
μ = 10.00
ρ = 0.14
WC FT = 0.50
Travel
FLOW
Requests/Day
44.50
NNP Travel
Servers 5.50
Avail Min 2475.00
Service Ti Load
45.00 2002.50
Utilization 0.81
Inputs
λ = 44.50
ts = 45.00
μ = 10.00
S = 5.50
Results
FT = 0.15
ρ = 0.13
WC FT = 0.55
Customer Requests/Day
FLOW
15.07
Contract Support
Servers 2.50
Avail Min 1125.00
Service Ti Load
80.00 952.50
Utilization 0.85
Inputs
λ = 15.07
ts = 80.00
μ = 7.50
S = 2.50
Results
FT = 0.40
ρ = 0.36
WC FT = 1.48