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MBA PROFESSIONAL REPORT

Cost Analysis for the Development and Operation of a Mobile Wireless Research Facility

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March 2004

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13. ABSTRACT ***(maximum 200 words)***

The Nemesis program's primary objective is to provide a mobile wireless research facility for Federal agencies and other authorized agencies. The report provides estimates of the Nemesis program's original cost, replication cost, scheduled costing for operational requirements, and budgeting guidelines. The report provides future funding request justification for both labor and equipment lifecycle costs. The report also provides the program funding agencies a more precise cost benefit analysis, to project future operating costs, and to provide standardized budget guidelines. The estimate of the original cost includes equipment acquisitions, software and reference material acquisition, inventory validation, billed labor, estimated non-billed labor, estimated non-billed infrastructure support, billed training and certification, estimated project management, and estimated administrative support. The estimate of the original cost does not include legal support and Governmental administrative requirements. The replicating cost is determined from the original cost with discovery costs removed. The discovery cost includes initial research/evaluation of alternate methods of system implementation, reduced expertise in labor due to documented replicating procedures, and an improved training process for operators. The costing schedule is based on the projected program-operating tempo. The budgeting guidelines provide the budget format, target parameters for inventory, and capital reinvestment to offset depreciation expenses.

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COST ANALYSIS FOR THE DEVELOPMENT AND OPERATION OF A MOBILE WIRELESS RESEARCH FACILITY

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Submitted in partial fulfillment of the requirements for the degree of

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EXECUTIVE SUMMARY

The Nemesis program realizes the concept of a Mobile Network Operations Center (MNOC) and Mobile Research Facility (MRF). The Nemesis program provides advanced research and development in wireless technology environments for the benefit of the Department of Defense (DoD) and other approved agencies. In 2002 the foundation was laid to stand up the Nemesis program in 2003. From late 2002 to late 2003, funds were granted to the Nemesis program from numerous sources such as Naval Information Warfare Activity (NIWA), Fleet Information Warfare Center (FIWC), and the Cebrowski Institute, to validate the proof of concept and produce the Nemesis program Mobile Network Operations Center (MNOC).

This research project qualifies and quantifies the costs associated with the creation, operation, and replication of the MNOC. Areas of financial analysis in the research project include: originating cost, replicating cost, mission costing, projected operating budgets, and annual funding request metrics.

Original cost of the project takes into account all traceable obligated funds, from different accounts, attributable to Nemesis. The original cost also estimates infrastructure costs, and indirect costs. NPS student contribution to the project in the areas of research and labor is also included in the original cost.

Replicating costs represents an estimate to produce a second MNOC. Replicating costs are segmented so that agencies other than the Naval Postgraduate School can apply the replicating estimate in light of the agencies resources.

Mission costing, operating budgets, and funding request metrics are also included. By establishing the expected number of 32 missions for FY 2004, specific mission costs could be established. The projected operating budgets and funding request metrics are based on the mission costing estimations, original costs, and life cycle expectations.

The financial analysis report not only provides an accounting record, a replicating cost basis, mission costing estimations, and operating budget projections it also provides a systematic approach to continue and refine the financial management of the Nemesis program. The approaches used in this report could be applied to other research projects so that similar analysis could be generated.

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I. INTRODUCTION

A. PROBLEM STATEMENT

The Nemesis program is a Mobile Network Operations Center (MNOC) research project that will conduct network attacks, assessments, and provide a platform to conduct cutting edge wireless technology research for military applications. As the Nemesis program came to fruition the financial analysis requirements inherent to program management became more relevant as a tangible product was generated. The motivation to generate a more comprehensive financial analysis was to provide the program funding agencies a more precise cost benefit analysis, to project future operating costs, and to provide standardized budget guidelines. The historical financial data provided a basis from which the financial analysis could be generated. The information provided from such analysis will establish a basis by which: an appropriate level of additional funding can be determined; comparable products can be generated; cost benefit analysis for various operational missions can be assessed; and future budgets can be generated using standardized methods so that different years' operating expenses verses productivity can be equitably compared.

B. BACKGROUND

Wireless communications technologies have a long history of use in the U.S. military. Military forces have used radio communications since the early 20th century. Even more archaic forms of wireless communications, such as signal flags, have been used for hundreds of years. It is clear that the military, as well as, society makes heavy use of wireless technologies today (such as cell phones and Global Positioning System (GPS)). This exploitation and expansion of the use of the wireless medium can only be expected to continue. The current generations of wireless communications that are proliferating at a significant rate are designated 802.11, 802.11a, 802.11b, and 802.11g by the Institute for Electrical and Electronics Engineers, Inc. For the purposes of this project we will refer to this group of related technologies as 802.11. This is because, even though they have different suffixes, they are all used for the same general purposes.

An important note concerning these technologies, that arguably, may be the reason that they are becoming so popular so quickly, is the cost to license the frequency spectrum they utilize. Currently, this cost is zero in many cases. In the 1990's the Federal Communication Commission (FCC) allocated bandwidth at 2.4 GHz for Industrial, Scientific and Medical (ISM) and the bandwidth at 5 GHz as Unlicensed National Information Infrastructure (U-NII) bands [Ref 1] for use by 802.11 technologies with no licensing fees.

Generally, FCC licensing fees are relatively high, which makes their use prohibitively costly. In part, the absence of licensing fees as they pertain to 802.11 technologies has allowed the equipment to be available to users at low prices. Price is not the only reason the 802.11 technologies are seeing rapid growth. Other reasons include ease of use, effectiveness, and the non-proprietary nature of these technologies. Because of these and other features of 802.11 technologies, their popularity, along with the number of applications is expected to increase. [Ref 2]

As the cost of 802.11 technologies decreases and their capacity increases the use of 802.11 technologies becomes more attractive to the Department of Defense (DoD) and other Federal Government agencies. The increased level of convenience and cost efficiency, with respect to implementing 802.11, technologies is projected to continue well into the future, as shown in Figure 1. Convenience and cost efficiency will continue to motivate DoD and other Federal Government agencies to increase the level of implementation of wireless systems, specifically wireless local area networks (WLANs). 802.11 technologies are presently used for WLANs on ships and shore stations. They are also used for administrative applications and to monitor and regulate mechanical and electronic systems. [Ref 3, 4]

In addition to convenience and cost efficiency, the mandates of developing a transformational military force will require the integration of 802.11 technologies into DoD support and operational infrastructure. A primary example of force transformation necessitating operational WLANs is ForceNet[1]. This transformational approach to battlefield situational awareness and coordination is contingent on two primary technology areas, micro miniature sensors and WLANs. There are unlimited potential transformational tactics that could be realized by exploiting 802.11 technologies (WLANs). To evaluate the effectiveness of the tactical implementation of 802.11 technologies in the field ideally requires a mobile WLAN. The WLAN should be configurable in a wide variety of capabilities-based setups. Another requirement for WLANs would be that they be fully compatible with newly developed wireless technology. This requirement translates into a WLAN that can be updated as technology turnover occurs

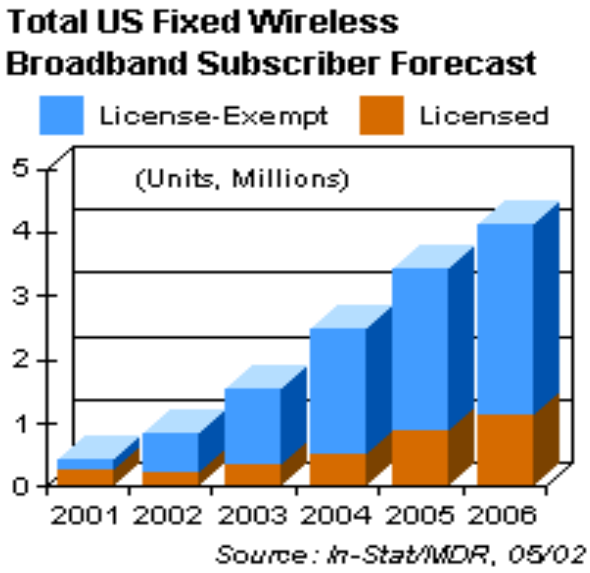

Figure 1. Projected growth of wireless application [Ref 5].

[1] **ForceNet: Enabling 21st Century Warfare**

ForceNet is the "glue" that binds together Sea Strike, Sea Shield, and Sea Basing. It is the operational construct and architectural framework for naval warfare in the information age, integrating warriors, sensors, command and control, platforms, and weapons into a networked, distributed combat force.

The advantages of using 802.11 technologies in their current form come at the cost of creating greater system exploitability, for adversaries. This exploitability comes in the areas of information security, operational disruption, and operational security (OPSEC). A procedure that could be used to reduce the risk inherently associated with 802.11 technologies is to evaluate a WLAN for vulnerability then design and apply patches to reduce or eliminate areas of weakness. To evaluate the robustness of a WLAN against attack requires an external system that can aggressively attack a WLAN using current and newly developed tactics and techniques. To conduct the attacks on the numerous WLANs, with different configurations, in different geolocations has several requirements. The first is a Mobile Network Operations Center (MNOC) to service remote locations. The second requirement is that the MNOC be configurable in a wide variety of capabilities based setups. These two requirements mirror the requirements necessary to evaluate the effectiveness of tactical implementations of 802.11 technologies. [Ref 6] The third requirement in the evaluation process is having the knowledge of WLAN weaknesses, being able to implement an attack which exploits WLAN weaknesses, and innovating to discover new WLAN weaknesses. The last requirement is that the attacking MNOC should be sufficiently capable of carrying out both common and innovative attacks on target WLANs. This final requirement corresponds to the last requirement in the evaluation process of tactically implementing 802.11 technologies. [Ref 6]

In light of the need for a capable MNOC, the Cebrowski Institute (CI) and Naval Information Warfare Activity (NIWA) funded Mr. Brian Steckler, an NPS Information Systems department faculty member, to spearhead the research and development of a project that would meet or exceed all stated requirements. The Network Warfare Van (NetWarVan) was developed. The project is labeled the “Nemesis Program”, and Nemesis' mobile vehicle is the NetWarVan, which is an MNOC. The NetWarVan is a re-configurable mobile computer network platform that can be used for:

- Evaluating WLANs through exploitation attacks.
- Establishing procedures/configurations to defend against exploitation attacks.
- Developing innovative methods of exploitation attacks.
- Conducting research that develops the tactical implementation of 802.11 technologies, from proof of concept through final testing.

The initial configuration of Nemesis is primarily focused on evaluating 802.11 WLANs and research projects using the IEEE 802.11 wireless standard. Follow on areas of wireless technology research will include, but not be limited to, cellular, VHF, UHF, free space optics, and satellite communications. In light of the Nemesis' broad scope of present and future application influences and the program's objectives, Nemesis was aptly named. Two of the Nemesis program's primary objectives are to reveal system weaknesses and to provide order, both of which are in keeping with the Greek goddess Nemesis, who was best known for her deep dislike of excessive pride and false confidence, and for being zealous in her pursuit to re-establishing order.

C. PRIMARY CONTRIBUTIONS

This research project will provide estimates of the Nemesis program's original cost, a rough cost of replication, a costing schedule for operational requirements, and provide budgeting guidelines. The estimate of the original cost will include, but not necessarily be limited to, equipment acquisitions, software and reference material acquisition, inventory validation, billed labor, estimated non-billed labor, estimated non-billed infrastructure support, billed training and certification, estimated project management, and estimated administrative support. The estimate of the original cost will not include legal support and Governmental administrative requirements, as this is beyond the scope of this analysis. The replicating cost will be determined from the original cost with the discovery cost removed. The discovery cost will include, but not be limited to initial research/evaluation of alternate methods of system implementation, reduced expertise in labor due to documented replicating procedures, and an improved training process for operators. The costing schedule will include the associated cost for

operating the system at specified distances from its home base (within CONUS), with various manning requirements, in various operating environments (subject to availability of support services), and with respect to mission dependant equipment configurations. The budgeting guidelines will provide the budget format and target parameters for inventory and capital reinvestment of technology as equipment is superseded.

II. ORIGINAL COST

The four primary types of original cost are equipment, labor, travel, and infrastructure. This chapter each type of primary cost, a short description of the replicating costs, and a summary of these costs. For each primary type of original cost this chapter gives: a brief description, general guidelines used to evaluate that type of cost, and the totals of the various categories and subcategories. This Chapter ends with a short summary of these costs. The accounting data underlying the calculations in this chapter are presented in Appendix A.

A. EQUIPMENT

The first of the four primary types of original cost is equipment. Expenditures classified as equipment include all technical and non-technical products that were obtained for use with the Nemesis program. The acquisitions for Nemesis include direct procurement for the program as well as products and services that were obtained through NPS' organizational infrastructure such as, the concrete slab for the NetWarVan and purchasing services.

The order of precedence for allocating a cost to equipment used in the project is acquisition cost, historical comparison, and current market value. In Appendix A, the equipment is costed using acquisition cost, unless labeled otherwise. Acquisition cost is based on the total acquisition cost, which includes associated costs of acquisition (i.e., transfer, installation, and delivery). If acquisition data were unavailable, cost of equipment was based on similar equipment purchases in roughly the same time frame. When acquisition data and historical data are not available, then a current market value estimate is used. Current market value estimations are determined through pricing of similar, new technology.

Equipment is separated into six basic categories: network equipment, radio equipment, antennas, software, power equipment, and support equipment/material. Four of the basic equipment categories have subcategories. Subcategories allow for easy

differentiation within the respective basic category. The total cost of each category and their subcategories are listed in Table 1.

Table 1. Equipment cost totals for categories and subcategories.

Equipment Category	Subcategory	Sub-category Total Cost	Totals
Network	Computers	$73,972	
	Routing Devices	3,076	
	Access Points	8,321	
	Peripherals	46,015	
		Total Category Cost	131,385
Radio	Radio	80,797	
		Total Category Cost	80,797
Antenna	Antenna	2,863	
	Peripherals	7,866	
		Total Category Cost	10,729
Software	Software	31,225	
		Total Category Cost	31,225
Power	Power[1]	18,921	
		Total Category Cost	18,921
Support	Vehicle[2]	42,888	
	Maintenance/Repair Equipment. etc.	1,514	
	Conversion[3]	7,671	
		Total Category Cost	52,074
		Total:	**$325,132**

[1] Includes the added generator, the NetWarVan's pre-existing generator, and the Hydrogen Fuel Cell (HFC), electrical distribution upgrade.

[2] Includes acquisition, tax, license, extended warranty, etc

[3] Includes network associated wiring, racks, etc

Assigning basic categories and subcategories allows for the differentiation of cost and also facilitates determining both replicating cost (Chapter 2, Section E) and mission costing, (Chapter 3, Section C). The data in Table 1 are a summary of the accounting

data in Appendix A. The data in Appendix A is a compilation of purchase orders, Special Programs Financial Analyst (SPFA) transaction data, and inventory data.

B. LABOR

The second primary type of original cost is labor. Labor is divided into two basic categories: billed and non-billed labor. Billed labor consists solely of program management. Billed labor could be expanded to include consulting work if that were necessary. Labor costs associated with equipment installation, maintenance, and repairs are not included in billed labor. Labor associated with equipment installation, maintenance, and repair is included in equipment costs and is labeled associated costs, as mentioned in the preceding section. Non-billed labor is student labor that is performed in conjunction with classes, independent study, thesis work, and volunteering. Non-billed labor does not include costs associated with acquisition and accounting support performed by the command's infrastructure. Accounting support costs are covered in the infrastructure cost (Chapter 2, Section D). Table 2 shows the cost of billed labor paid to consultants and the program manager.

Table 2. The cost of billed labor.

	Hourly rate (03)	**Total Hours (03)**	**Total Cost**
Program Manager	$47.08 and $49.37*	128	$8,879.49
Contractor	-	-	-

* Hourly rate includes labor acceleration and indirect costs. The Labor rate also varied throughout the year (48 hrs worked at the 1st rate and 80 hrs worked at the 2nd rate)

Determining the cost of non-billed labor was not as straight forward as determining the cost of billed labor. To estimate non-billed labor it was necessary to estimate both hourly rate and total number of hours worked by multiple students (some of who have graduated and transferred). To do this, the process in Figure 2 was developed.

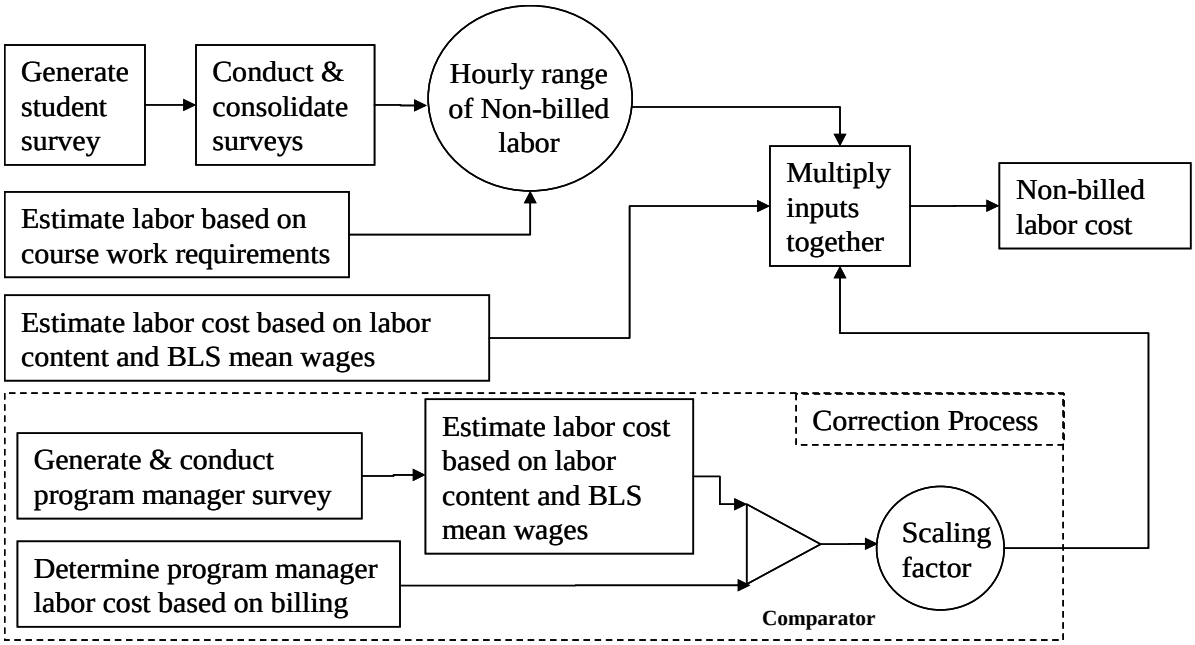

Figure 2. Wage rate estimation model. (Bureau of Labor and Statistics (BLS)).

For the first step in the process, a non-billed labor survey was developed and executed by NPS students and faculty involved in the NetWarVan program. The primary sources of non-billed labor are students enrolled in three NPS courses. The three courses are IS4925 (Wireless Local Area Network (WLAN) administration management and security), independent studies, and thesis periods. A fourth area of additional work is used to ensure that all areas of potential labor are included. The labor associated with the courses is broken down into five areas: learning, technical labor, manual labor, administrative labor and "Other" labor is included as a residual for areas of labor not covered in the first four labor categories. "Learning" labor type is used to determine the number of hours committed to the class did not directly involve development of the Nemesis program. The "Learning" labor is useful to the Nemesis program so, for costing purposes this category of labor is included in the infrastructure section of this chapter. The "Technical" labor is primarily network related work, due to the nature of the program. The "Manual" labor section covers all work that could be conducted by unskilled laborers. The "Administrative" labor is primarily focused on acquisition and inventory. The "Other" labor category provides a description of each type of labor so that

it can be properly costed. A copy of the survey, the completed surveys, and all data compiled from the surveys are listed in Appendix B. A summary of the survey results is shown in Table 3.

Table 3. Total hours of non-billed labor from survey.

Course Work / Types of Labor	IS4925	Directed Study	Thesis	Costing	Additional	Total
Learning	138	48	66	24	0	**276**
Technical	246	54	24	18	42	**384**
Manual	132	78	12	12	0	**234**
Administrative	102	18	36	126	0	**282**
Other	6	6	6	18	0	**36**
Total	**624**	**204**	**144**	**198**	**42**	**1212**

After the survey was conducted and the data consolidated, a comparative measure of the labor was estimated based on course work requirements. For this estimation it was assumed that for every hour in class, 2 to 3 hours of out of class work was accomplished. The survey data results are within this estimated range of labor for the course work, so data from the survey are used as costing data.

To estimate the hourly cost of the labor content, each of the other four types of labor (Technical, Manual, Administrative, and Other) are compared to job descriptions provided by the Bureau of Labor and Statistics (BLS). BLS job descriptions that most closely correlate to the types of labor we have identified are used to estimate the cost of the labor. The mean cost per hour, of the respective jobs, is used to estimate labor cost. If multiple job descriptions correlated with labor types, the average of the wages for the correlating job descriptions is used for the Labor type wage. Wage rates are National averages and have not been adjusted for geographic area. Table 4 lists jobs and corresponding hourly wages that are used to estimate labor costs. Descriptions used to estimate labor costs are listed in Appendix C. An additional category is added to the labor types, since, for some surveys, administrative labor is accounting based vice acquisition and inventory based.

Table 4. Hourly wage estimates for non-billed labor types.

Non-Billing Labor	Job Title	BLS #	$/hr
Technical Labor	Computer Support Specialists	15-1041	20.16
	Network and Computer Systems Administrators	15-1071	27.14
	Network System and Data Communications Analysts	15-1081	28.99
	Average wage for Technical labor ($/hr)		**25.43**
Manual Labor	Electrical and Electronics Installers and Repairers, Transportation Equipment	49-2093	12.85
	Recreational Vehicle Service Technicians	49-3092	13.36
	Maintenance and Repair Workers, General	49-9042	14.54
	Helpers--Installation, Maintenance, and Repair Workers	49-9098	11.16
	Average wage for Manual labor ($/hr)		**12.98**
Administrative Labor	Bookkeeping, Accounting, and Auditing Clerks	43-3031	13.38
	Wholesale and Retail Buyers, Except Farm Products	13-1022	21.25
	Weighers, Measurers, Checkers, and Samplers, Recordkeeping	43-5111	13.1
	Data Entry Keyers	43-9021	10.93
	Procurement Clerks	43-3061	14.17
	Average wage for Administrative labor ($/hr)		**14.57**
Costing Labor	Accountants and Auditors	13-2011	24.37
	Budget Analysts	13-2031	21.25
	Bookkeeping, Accounting, and Auditing Clerks	43-3031	13.38
	Average wage for Technical labor ($/hr)		**19.67**
Other	**Average wage for All Occupations**	00-0000	**16.35**

Wage rates we use for labor types seem reasonable because they are based upon BLS' data. However, this method of costing has not been validated. A major drawback of this approach is that the full costs to employers for employees are not included. Items such as insurance, retirement, unemployment tax, and other fringe benefits are not a part of these wage rates. Another shortfall of this cost estimate is that the task familiarity of the non-billed laborer may be less than those laborers who do the job all the time. Although the training, education, and motivation of the non-billed laborer may more than offset any lack of familiarity. Since there are so many items that are undeterminable, the

concept of a correcting process through a scaling factor is introduced. To determine the scaling factor, a new costing model is generated for known data (i.e., the program manager's cost information).

Program manager labor survey data is provided in Table 5. The original program manager survey is also in Appendix B. A Labor type cost estimate is generated using BLS data in Table 6. Job descriptions used to construct labor type costs are in Appendix C. The labor type wage model generated wages ranging from $22.27/hr to $41.54/hr. The billed labor rate varied from $47/hr to $50/hr. The major reason that the wages used to estimate the billed labor are considerably lower than the billed labor hourly rate is that the billed hourly rate is corrected to reflect the actual cost of the labor (i.e., it included additional direct and indirect costs). The amount that labor is billed at is 66 percent higher than the wage rate of the labor that is being billed; 66 percent is the sum of accelerated labor cost (43 percent) and indirect cost (23 percent). The accelerated labor cost is composed of the leave (17 percent) and fringe benefit (26 percent) costs. The fringe benefit rate of 26 percent includes the costs of life insurance, health insurance, social security, thrift savings plan, and retirement. [Ref 7] Indirect costs are used to recover the cost of administrative components that provide indirect support and are not easily identifiable from direct labor costs. Some examples of administrative activities that provide this support are travel, accounting, information technology, human resources, library support, public affairs, and legal. [Refs 7 and 8]

Adjusting billed wage rate to include accelerated labor and indirect costs results in a wage rate of about $30/hr. This wage rate corresponds to the salary and number of hours worked per week for the program manager (the wage rate is between $30/hr and $35/hr for a 60-70 hr work week). Using the model and program manager survey data, the resultant hourly wage is $27/hr. From these results, our model's estimate of the hourly wage rate is low by about 10 percent, per the billed wage rate, not including the accelerated labor and indirect costs. The comparator correction is the 10 percent underestimation of the wage rate shown by the comparator step in the wage rate estimation model.

The next step in the wage rate estimation model is the scaling factor. The scaling factor step corrects for the comparator correction (the 10 percent underestimation), and accounts for labor acceleration and indirect costs. The rates for labor acceleration and indirect costs associated with non-billed labor use the same rates as designated in. [Refs 7 and 8].

Table 5. Tabulated data from the program manager labor survey.

Quarter	**WN02**	**SP02**	**SM02**	**FL02**	**WN03**	**SP03**	**SM03**	**Hr/Wk Total**		**Cost/hr**	**Total Cost**
Total (hrs/week)	27	14	14	14	16	26	36	147	1764		$0.00
Specifics											
Research	11	6	6	6				29	348	37.04	$12,889
Acquisition	10	5	5	5	5	5	8	43	516	22.27	$11,491
Administration					10	10	5	25	300	22.27	$6,681
Formal Instruction						5	10	15	180	*	
Informal Instruction	3		2	2		5	5	17	204	37.04	$7,556
Field Testing							5	5	60	41.54	$2,492
Presentations	3	3	1	1	1	1	3	13	156	41.54	$6,480
										Total	**$47,591**
								Labor acceleration and indirect costs correction			**$79,001**

*Included in infrastructure cost, Chapter 2, Section D.

Table 6. Hourly wage estimates for labor types for program manager labor.

Program Manager			
Research	Computer Science Teachers, Postsecondary	25-1021	**37.04**
& Informal Instruction	Wage based on 1,560 hrs worked per year		
Acquision	Engineering Managers	11-09041	42.74
& Administration	Computer and Information Systems Managers	11-03021	40.33
	Bookkeeping, Accounting, and Auditing Clerks	43-3031	13.38
	Wholesale and Retail Buyers, Except Farm Products	13-1022	21.25
	Weighers, Measurers, Checkers, and Samplers, Recordkeeping	43-5111	13.1
	Data Entry Keyers	43-9021	10.93
	Procurement Clerks	43-3061	14.17
	Average wage for Acquision and Admin labor ($/hr)		**22.27**
Field Testing	Engineering Managers	11-09041	42.74
& Presentations	Computer and Information Systems Managers	11-03021	40.33
	Average wage for Field Testing & Presentations ($/hr)		**41.54**

A summary of the non-billed labor estimation is shown in Table 7. The estimated non-billed labor is approximately $43,000. This estimation includes the missed survey projections, the comparator correction, and rates for labor acceleration and indirect costs.

Table 7. The non-billed labor estimate summary.

Model projection cost based on survey input	**$17,074.32**
Average projection of cost based on 9 students in IS-4925	$18,268.49
Average projection of cost based on 4 students in Directed Studies	$21,929.85
Average projection of cost based on 4 students 3 in Thesis work	$23,781.45
Comparator correction factor 10%	$26,159.60
Labor acceleration and indirect costs correction	$43,424.93

Evaluating the cost of billed labor as a function of total cost vice hourly wage rate of billed labor brought to light a purposeful and significant underestimation policy with respect to billing labor. The total billed labor cost is $8,879.49 which is much less than the approximately $90,000 that could have been billed using the labor rate, labor acceleration rate, indirect cost rate, and the number of hours worked. The significant differences in billing amounts are due to the nature of the academic environment and the conservative billing approach of the program manager. To more accurately reflect the original cost, the billing potential of $90,000 was used.

C. TRAVEL

Travel costs are determined using the adjudicated accounting data from the NPS travel office. Travel costs, other than the costs that were processed through the travel office, were not identified during the investigation. Travel costs are separated into three categories: acquisition/training, program management, and testing. The last two categories have the potential to overlap since the program manager is obviously involved in the testing phase. To remove potential overlap, the program management travel category excluded program manger travel for testing. Using the data in Appendix A, a summary of travel costs are provided in Table 8.

Table 8. Summary of Nemesis project origination travel cost.

Travel Cost	**Total**
Acquisition/Training	$3,068
Program Management	479
Testing	851
Total	4,399

The travel cost categories above facilitate the determination of costs that are fixed (i.e., training and program management) and necessary in order to maintain a vital program as well as to identify the variable cost of operating (i.e. testing). Fixed and variable costs are then appropriately included in determining the operational costs (Chapter 3) and generating a budget mission (Chapter 4).

D. INFRASTRUCTURE PREVIOUSLY UNACCOUNTED FOR

Infrastructure can be viewed as both indirect and direct overhead. The indirect infrastructure cost has been captured in the indirect cost associated with labor. The two primary areas of direct infrastructure cost that have not been fully included to this point in the report are physical and intellectual. The primary physical infrastructure direct overhead elements are the lab room, the lab utilities, and the NetWarVan's storage location. The cost of these facilities is estimated through comparative cost in the commercial sector. Since the facilities are located in Monterey, California, the estimates for comparison are relevant only to the Monterey area.

The Monterey Chamber of Commerce and a Commercial Real Estate Broker (Mahoney-Tancredi-Lostrom Co) provided average office space rental property price ranges ($1.30-$2.50 per square foot) as well as average utilities (10 cents per square foot). The size of the lab is approximately 320 square foot. Since the storage for the NetWarVan was not outsourced, the cost for storage on government property was also

calculated. The cost of the concrete slab used for the NetWarVan was $19,000. The cost of security and government land use was estimated by using 80% of the rate of a local DoD Recreational Vehicle (RV) storage facility that is operated by the NPS Morale Welfare and Recreation Department. The reason that 100% of the rate is not used is that the storage does not require any administrative support such as collection, accounting, and registration. The results of the direct overhead cost estimates are listed in Table 8.

Table 9. Physical infrastructure costs.

Description	**Entry cost**	**Ongoing cost**	**Accumulated Ongoing Cost**	**Initial Month**
Lab room	$1080 [1]	540 / month	$2700	Apr 2003
Lab utilities	60 [2]	30 / month	300	Apr 2003
RV storage	19,000[3] No cost[4]	20 / month,[3] 100 / month,[4]	80 400	May 2003
Total	20,140	590 / month	3080	**$23,220[5]**

[1] First and last month's rent of $540 a month.

[2] Utilities deposit

[3] Corrected government rate with initial cost of $19,000 and used for totals.

[4] Commercial rate. The commercial rate is not included in the total.

[5] The final bold total is the sum of the entry costs and the accumulated ongoing costs.

The intellectual infrastructure direct overhead elements were limited to a portion of the cost of training personnel in the non-billed labor category. The learning (that did not directly develop Nemesis) category from the non-billed labor surveys reflected a training cost that familiarized the work force with the project so that they could perform their respective tasks. This familiarity training is an indirect cost to all organizations and thus should be reflected as a cost. Due to the nature of the non-profit educational environment, the total learning cost should not be borne by the project; rather some small portion of the labor should be included at a reasonable cost. Due to a lack of available data as to the percentage of labor costs that should be attributed to training expense, for a commensurate organization, the percentage was simply estimated. The estimate is based on the idea that, out of a 40 hour work week, one or two hours will be used for training purposes. From this assumption, the average labor cost associated with training would

range from 2.5 percent to 5 percent of the total labor cost. To remain conservative, the lower estimation was used as an upper bound for the total estimated cost of the non-billed labor. This estimation bounded the hours spent on training to 30.3 hours or 2.5 percent of the total number of non-billed labor (.025 x 1212 = 30.3). Since the value of the bounded estimation was much less than the surveyed data (276 hours) in Table 3, the 30.3 hours was used as the estimation for the training expense for non-billed labor. In addition to determining an upper bound on training time for non-billed labor a wage rate was also estimated. The wage rate used for the non-billed labor training cost was the average labor rate per the BLS. The cost of training for non-billed labor was then estimated as the product of the upper bound on the training hours and the wage rate (30.3hr x $16.35/hr = $495).

E. ORIGINAL COST SUMMARY

The original cost associated with the Nemesis program is **$486,247**, which was generated using the data from the previous sections in this chapter. The results are itemized and summarized in Table 9. For a discussion on the year-to-year correction of the cost and a method that could be used to determine the cost of replicating the project, see the next section in this chapter.

Table 10. Original cost summary.

Type	Category	Subcategory	FY 2002	FY 2003	Total
Equipment					
	Network	Computers		$73,972	
		Routing Devices		3,076	
		Access Points		8,321	
		Peripherals		46,015	131,385
	Radio	Radio		80,797	80,797
	Antenna	Mounted			
		Antenna Pod			
		Peripherals			10,729
	Software	Software		31,225	31,225
	Power	Power		18,921	18,921
	Support	Vehicle		42,888	
		Maintenance/Repair Equipment, etc		1,514	
		Conversion		7,671	
		Miscellaneous			52,074
Labor	Billed Labor	Program Manager	42,245	47,755	90,000
		Contractor	-	-	-
	Non-billed Labor			43,000	43,000
Travel	Acquisition/Training		-	3,068	3,068
	Program Manager.		-	479	479
	Testing		-	851	851
Infrastructure*	Physical		-	23,220	23,220
		Lab	-	*3,780*	
		Lab utilities	-	*360*	
		RV Storage	-	*19,080*	
	Intellectual		-	495	495
Total					**$478,802**

- Italicized numbers are shown for completeness and are already included in the category cost.
- *Infrastructure not previously accounted for

F. REPLICATING

To determine the cost of replicating, two primary considerations are applied to the original cost: (1) inflation adjustment, using the consumer price index (CPI); (2) the approximation of discovery cost used to estimate replicating costs, based on the original cost. The inflation adjustment uses the CPI for FY 2002 as the base year. For FY 2003, the CPI for the months October through August is averaged to be 2.35 percent. The CPI correction of 2.35 percent was factored into all FY 2002 costs, so that the replicating cost is then based exclusively on FY 2003. This common cost base facilitates the future projection of replicating costs based on the CPI rate of future years. As an example; if the CPI for FY 2004 is 2.5 percent and the CPI for FY 2005 is 2.3 percent then the cost of replicating in FY 2005 could be approximated as the replicating cost based on FY 2003 (provided in Table 10) times 1.025 and 1.023 (the product of the respective years CPI rates).

The second factor for determining replicating cost is the discovery cost. Discovery cost is the cost associated with initial conception and the research and decision making process that went into determining the final project. The very nature of discovery costs dictates that these costs would not be incurred if the original work force or an equivalent substitute work force replicated the product. To ensure that a work force is an equitable substitute, the work force must be similarly trained, have unrestricted access to the data, and organizational documentation of the Nemesis project, be familiar with the data, and periodically contact the Nemesis team to be advised on large scale planning and troubleshooting. The last requirement infers that the Nemesis program is still in operation and is continuing with its mission of applicability and research in wireless technology. Another factor in replication that is implied but not stated is that the replication is very similar to the NetWarVan when replication is implemented. As previously stated, this assumes that the NetWarVan has been updated to maintain its relevance and applicability. The trend of technology decreasing in relative price, while it increases in capability would tend to keep replicating costs at the same order of

magnitude. This assumes that the NetWarVan's mission did not deviate significantly from the initially stated mission of applicability and research in wireless network technology.

Based on the previous assumptions, the replicating cost is then the difference between the original cost and the discovery cost as shown below.

Replication cost = Original cost – Discovery cost

The discovery cost is not at all relevant to equipment. The reduced cost of replicating is primarily realized in the labor cost. The reduced cost of labor is associated with acquiring the requisite knowledge in both the decision making process and project implementation. The decision making process is the cost area that is the most dramatically reduced. A prime example of the analysis that was conducted and that is of considerable value in the replicating process, is the mobile platform evaluation used to determine what vehicle would be most appropriate to house and transport the mobile network (see Appendix D). This analysis is extremely valuable in decision-making. Reviewing the program manager work type categories shows that there are two areas that directly affect discovery cost: research and informal instruction. These two areas constitute 43 percent of the program manager's original cost. Non-billed labor did not directly affect discovery cost.

With intellectual infrastructure, it could be argued that the discovery costs are relevant. An additional cost could be familiarization cost, considering that an equitable substitute work force would need to be familiar with the program data and documentation. The reduced cost due to the discovery cost savings would be offset by the aforementioned cost of familiarization. A similar analysis of travel, with respect to discovery cost, shows that replicating cost would be comparable with original cost. The replicating cost is summarized in Table 10.

Table 11. Replicating cost summary.

Type	**Total**
Equipment	$325,132
Labor	94,000
Travel	4,399
Infrastructure*	23,220
	$446,751

III. MISSION COSTING

Mission costing provides a mechanism by which to compare associated costs of a mission, with the results generated by a mission. Since the results or gains of a mission are very difficult, if not impossible, to measure in monetary terms, cost analysis of the results generated by a mission will not be considered. Although a pro vs. con cost analysis is not viable, mission costing provides a measure by which research funding organizations can determine whether the associated costs of a mission are commensurate with the research results that are produced. Funding organizations can use mission costing to assess a funding support level for Nemesis that is in line with their vision.

We can view the cost of the mission associated with the Nemesis program as being composed of three areas of cost: direct costs, overhead cost (OH), and period costs. Direct costs are composed of direct labor (DL) and direct materials (DM). OH costs are composed of vehicle, power, and technical equipment. Costs associated with OH categories are separated into five mission related activities: transportation, setup, mission execution, RV accommodations, and power generation. Period costs are the last of the three areas of cost that are covered. Period costs include infrastructure, non-mission related travel, and indirect costs that are not included in OH. Such costs are charged to Nemesis missions since the resources are dedicated to the Nemesis program. The above direct, overhead, and period costs are determined they are integrated to establish Nemesis mission costing.

A. DIRECT COSTS

In this section, direct cost categories DL and DM are described and further differentiated into subcategories. For continuity, DL is presented first, followed by DM. The DL category includes all labor costs incurred for mission setup, travel, mission execution, and research documentation. Mission setup includes both administrative scheduling and organizing as well as physical setup and re-stow requirements of equipment. The travel subcategory includes round trip transit time to and from the mission sites. Transit time is counted as labor time for all subcategories of labor with

respect to costing missions. Labor time is expected to be approximately 9 hours per day, and transit time is capped at 8 hours per day for safety considerations.

DL is comprised of four subcategories: program manager, technician (permanent party), technician (contracted), and non-billed. Wage rates for the four subcategories are listed in Table 12. The wide variety of mission types and required mission manning combinations make it infeasible to generate a complete list of possible configurations. In lieu of a comprehensive labor description, basic mission labor guidelines are provided.

Table 12. Wage rates for DL subcategories.

Category	**Subcategory**	**Cost / Consumption Rate**	**Cost / Consumption per day ($)**
DL[1]	Program Manager	$50/ hour	$450 (avg.)
	Tech (Permanent Party)	25/ hour	225 (avg.)
	Tech (Contracted)	45-65/hour	405-585 (avg.)
	Non-Billed[2]	25/hour	225 (avg.)

[1] DL cost includes labor acceleration and indirect costs described in chapter 2. A 9 hour work day is assumed.

[2] The wage rate for Non-billed labor is referenced from Table 4. Hourly wage estimates for labor types for non-billed labor, in the Technical labor section.

A summary of guidelines for mission labor is presented in Table 13. For the administrative requirements of mission setup, members of the Nemesis organization may assist in scheduling missions; however, the program manager is the only person authorized to schedule missions. The physical aspect of setup consists of loading out the NetWarVan at the lab, setting up equipment at the mission site, re-stowing equipment at the conclusion of the mission, and re-stowing equipment in the lab. The physical setup evolution is approximated to be 20 hours of technical labor (4 man-hours each for the first and last elements and 6 man-hours each for the middle two elements of the physical setup).

Labor associated with travel is approximated as 1 hour of labor for every 50 miles that are traveled, for each labor type. This gauge of the labor costs associated with travel is conservative since the MNOC generally travels slower than the flow of traffic and no fuel or food stops are included.

Table 13. Summarized guidelines for mission labor.

	Program Manager[1]	Technician[2] Non-billed
Setup (administrative)	TBD	TBD
Setup (physical)	-	20 man-hours per mission
Travel[3]	1 hour per 50 miles	1 hour per 50 miles
Mission Execution	TBD	0-6 Labors per mission[4]
Document Trip Report	2 hours per mission	15 min per Laborer per mission
Document Thesis Report[5]	30 hours pro-rated	600 hours pro-rated

[1] Program manager labor can be substituted for the technician but this is not economical.

[2] Technician labor can be a DoD employee or contracted labor.

[3] Travel estimate of 1 hour of labor per 50 miles of distance traveled, capped at 8 hours per day.

[4] Nemesis can be manned with program manager approved operators external to the Nemesis organization.

[5] This row estimates the cost if a thesis is written based on a single mission. Cost would be spread over multiple missions if a thesis' primary focus encompasses the results of multiple missions. This also assumes that the program manager is the primary thesis advisor. The pro-rating wage rate is due to the dual set of requirements that are being satisfied.

Labor associated with missions has a range between no operators (i.e., Nemesis is manned by operators that are not part of or hired by the Nemesis organization) and six operators (mission supervisor is one of the six operators). Although the program manager may or may not go on the mission, if the program manager is present, then he will assume the role as mission supervisor. The program manager determines which missions he will go on based on mission requirements. Whether the program manager goes on a mission or not, the program manager will finalize a standard mission documentation report. Standard mission documentation is captured in the trip report. The trip report is a brief summary of the missions' accomplishments and resource contacts such as general information, dates, purpose, lessons learned etc.

Trip reports, mission documentation, and analysis are commonly incorporated into a thesis. An approximation of the amount of labor that is necessary to produce a thesis is included in Table 13. The program manager labor estimation is based on the assumption that the program manager is the primary thesis advisor. The mission cost of a

thesis is directly dependant on the number of missions a particular thesis relies upon. This means that if the thesis makes use of the results of multiple missions, then the mission cost due to thesis research would be spread over multiple missions. Attributing mission costs to thesis work is also considered in mission costing. Many thesis projects will not be completely focused on analyzing and documenting the mission(s) and/or may provide additional analysis and documentation that is not necessarily directly relevant to the mission. Thesis work has specific format requirements that require time that doesn't necessarily benefit Nemesis, and the pro-rates should take this into consideration. The previously mentioned factors indicate that the mission costs associated with thesis related labor should be pro-rated. The pro-rate factor will be determined on a case-by-case basis as determined by the program manager.

The second category of direct cost is DM. DM is also described and further differentiated into subcategories. The DM category includes all material costs incurred due to travel, personnel expenses (other than labor), and mission execution. The DM cost associated with setup and documentation is negligible and will not be described in this project. The DM subcategories are: MNOC fuel, gas generator fuel, lodging, per diem, bottled hydrogen (used for the HFC), and satellite internet. DM guidelines for missions are presented in Table 14. The MNOC fuel and the generator fuel are given separate subcategories even though the MNOC and the generators are both fed from the same fuel tanks. Motivation for the separate categories is to provide for a more accurate estimate of mission costing depending on whether the mission requirements include or exclude power generation by Nemesis generators. In some cases the mission site has a power source from which the NetWarVan is powered. In such cases the generators only provide a backup source in the event of primary power failure. Estimated DM fuel cost can be determined by applying the current fuel prices to the estimated consumption rates in Table 14.

Respective lodging and per diem rates, per person, can be determined by using the web site listed in reference 4. The bottled hydrogen subcategory in table 14 is used to power the hydrogen fuel cell (HFC) generator. The HFC generator is used as a remote power source and provides up to 500 Watts of power. The HFC is considered standard

equipment for the NetWarVan and its mission related cost is included in OH under the power category. The rate of hydrogen use is approximately 1/8 tank per hour for a 40 lb tank. A 40 lb tank was used as the standard tank size although other tank sizes are available. The estimated daily use for missions requiring a remote power source with less than 500 Watts of power is 1 40 lb tank. The final DM cost comes from the use of the satellite internet which is costed at .79 cents per minute of use.

Table 14. Summarized guidelines for mission DM from historical data.

Category	Subcategory	Cost / Consumption Rate	Cost / Consumption per day ($)
DM	RV Fuel[1]	7 miles per gallon	50 Gallons
	Generator Fuel[2]	2 gallons per hour	16 Gallons
	Lodging[3]	-	Per Ref 10
	Per Diem[3]	-	Per Ref 10
	Bottled Hydrogen	1/8 Tank per hour	1 Tank
	Satellite Internet	79 cents per min.	-

[1] Consumption based on a maximum travel distance of 350 miles a day. (Joint Federal Travel Regulation, Vol I, Change 184, 4/1/02 [Ref 11])

[2] Consumption rate based on one generating running. Per day consumption assumes one generator runs for 8 hours.

[3] Rates vary per location and rank.

B. OPERATING TEMPO

Since the NetWarVan became operational in September of 2003, the annual operating tempo cannot be based on previous years' historical use. Therefore, we are projecting the operating tempo/annual use. The operating tempo projection is based on local missions scheduled within the first two months of NetWarVan's operations and anticipated out-of-area missions that are being scheduled for its first 12 months. Local missions include events at Big Sur and Camp Roberts, CA. A summary of the local missions is shown in Table 15. The Big Sur missions were cancelled due to non-availability of external research components. The cancelled Big Sur missions are included, however, since they are anticipated to form a core component of the local research missions. The Big Sur location presents a convenient mission location where

waivers (from the FCC) can be obtained so that the power of wireless transmissions can be increased beyond standard thresholds.

Table 15. Annual local mission projections summary (4 Sep 03-3 Oct 04)

Location	Dates	Duration (days)	Travel Distance (miles)	Power Generation (Y/N/Mixed)	Power Generation (# shifts)	Berthing (Y/N)
Camp Roberts	4 Sep-5 Sep	2	200	Mixed	2	N
Camp Roberts	11 Sep-18 Sep	8	200	N	0	Y
Big Sur[1]	2 Oct	2	40	Y	4	N
Big Sur[1]	14 Oct	2	40	Y	4	N
Camp Roberts	25 Oct-4 Nov	11	200	N	0	Y
Total	5 missions	25	680	-	10	4 days no Berthing
Annual Projection	30 missions	150	4,080	-	60	24 days no Berthing

[1] Mission was cancelled due to ship unavailability.

Local mission operating tempo is linearly projected using local missions scheduled between 4 September 2003 and 4 November 2003. A linear projection was used as the initial model for operating tempo projection based on the program managers initial growth projections and because a more complicated model is not supported by historical data.

Unlike local mission operating tempo, the rate of out-of-area missions could not be based on any historical data. Instead, out-of-area missions' operating tempo is based on events that are still being scheduled. Determination of which events should be included in the out-of-area mission operating tempo projection is based on which missions were likely to be scheduled. Two primary locations for out-of-area missions are expected to be in San Diego, CA and Seattle, WA. Potential alternate locations and costing data are listed in Table 16. Local mission costing data are also included in Table 16. It is projected that only one mission will take place, at each of the primary out-of-

area locations, within the year. These missions are projected to be about two weeks long each, excluding travel time. A summary of the out-of-area mission projection is included in Table 17.

Combining local mission projection with out-of-area projection generated a total projected operating tempo (see table 18). From projected operating tempo, four mission-cost drivers are determined. The four mission-cost drivers are: distance traveled, number of physical setups, number of power generation shifts, and number of mission days. The mission-cost drivers are used in OH allocation, which is covered in the following two sections.

Table 16. Travel cost and Per Diem for potential mission locations as of Nov 2003.

Location	**Travel Distance (miles)**	**Travel Time (days)**	**Lodging cost ($)**	**Per Diem ($)**
Big Sur, CA	20	< 1	n/a	n/a
Camp Roberts, CA	100	< 1	79	31.5
San Diego, CA	463	2	99	48
Seattle, WA.	907	3	143	48
Las Vegas, NV	531	2	79	40
FIWC (VA)	3000	9	109	40
San Antonio, TX	1696	5	91	44

*Lodging and Per Diem rates [Ref 10]

Table 17. Annual use projection for out-of-area missions.

Location	**Travel Duration (days)**	**Mission Duration (days)**	**Travel Distance (miles)**	**Power Generation (Y/N/Mixed)**	**Power Generation (shifts)**	**Berthing (Y/N)**
San Diego	4	14	929	N	14	Y
Seattle	6	14	1,814	Mixed	14	N
Annual Projection	10	28	2,740	-	28	14 -N

Table 18. Mission operation tempo summary

Location	Travel Duration (days)	Travel Distance (miles)	Mission setups	Mission Duration (days)	Power Generation (shifts)	RV Berthing (# Days)
Local Missions	-	4,080	30	150	36	36
Out-of-Area Missions	10	2,740	2	28	28	14
Annual Projection	10	6,820	32	178	64	50

C. OVERHEAD

OH costs are separated into four cost categories: vehicle, power, technical equipment, and period costs. The first three cost categories are covered in this section, and the period costs are covered in the next section. The vehicle OH cost category includes both MNOC acquisition and conversion costs. The Power OH cost category includes the gas generators as well as HFC generator costs. The technical equipment OH cost category includes all components in the network, radio, antenna, and software, original cost equipment categories. In addition to original cost, annual cost for maintenance and repair for each OH cost category is projected. The value used for each OH cost category is the sum of annually projected costs for maintenance/repair and annually distributed original cost, based on equipment life cycle for the items in each OH cost category: OH cost for category A = Annually projected maint/repair cost + sigma Items/life cycle

Annual distribution of original cost is determined by life cycle and the original cost of equipment in each OH cost category. The life cycle values are determined using the expected relevant and useful life of items based on program objectives, technology rollover, and the NetWarVans' expected life. The life cycle periods are divided into six different time frames (1 – 5 years, and 7 years). The primary program objective included in life cycle determination is that the program needs to remain relevant to wireless technology and research. To meet this objective, the rollover rate of technical equipment

must keep pace with changes in wireless technology. Recent history of wireless network technology indicates that the rate of technology turnover is driven by technology obsolescence vice equipment failure. A summary of the life cycle and annual OH cost for items within the vehicle, power generation, and technical equipment OH cost categories are listed in Table 19.

In addition to the life-cycle estimates, annual maintenance and repair costs for the vehicle, power generation, and technical equipment are also estimated. Maintenance and repair costs for vehicle and power generation categories are estimated to be $400 a year (see Appendix E). This estimate assumes that the NetWarVan will travel less than 10,000 miles per year, which is commensurate with the operating tempo section in this chapter. Further granularity with respect to these vehicle costs is included in Appendix E. In the event that a more exact breakdown of the cost is desired, a maintenance schedule is included in Appendix E. Annual maintenance and repair cost for technical equipment is estimated to be 5% of the annual cost. This number is relatively low since most of the technical equipment is fairly durable and warranted.

Table 19. Life cycle and annual OH summary (vehicle, power, technical equipment).

Category	Sub Category	Cost Category	Life Cycle (years)	Annual Cost	Maintenance/ repair (PM projection)	Annual OH
Network	Computers	TE[1]	2-4	$25,872	5%	$27,165
	Routers	TE	3	1,324	5%	1,390
	Access Points	TE	2	4,160	5%	4,368
	Peripherals	TE	2-7	20,142	5%	21,249
Radio	Radio	TE	7	11,542	5%	12,119
Antenna	Antenna	TE	2-5	727	5%	763
	Peripherals	TE	2	3,933	5%	4,129
Software	Software	TE	2	14,787	5%	15,526
Power	Power	Power	7	1,667	$33	1,700
Support	Vehicle	Vehicle	7	6,347	$367	8,503
					Total:	**96,818**

[1] TE = Technical Equipment

To allocate OH, missions are separated into five activity cost pools: transportation, setup, mission execution, MNOC accommodations, and power generation. The transportation activity cost pool includes costs associated with transporting the NetWarVan to and from mission locations. Costs associated with transportation are usage on the MNOC and increased failure rates of technical equipment due to increased jarring while driving. This cost pool is the primary source of OH for the vehicle OH cost category. Power system components (i.e. the gas and HFC generators) incur only nominal wear and tear due to transportation. The setup activity cost pool includes the four stages of physical set up and re-stow that are required for all missions. Since much of the technical equipment is stored in the lab at NPS, it must be loaded into the NetWarVan prior to a mission. Once the NetWarVan is at the mission site the system must be set up. When the mission execution phase of each mission is complete the NetWarVan system is re-stowed and transported back to the lab, where the technical equipment is re-stowed. The two components of setting up and the two components of re-stowing constitute the setup activity cost pool. Power system components, again, incur little to no wear and tear due to setup.

The mission execution activity cost pool provides usage for the vehicle, power, and technical equipment OH cost categories. This activity cost pool is the primary source of OH for the technical equipment OH cost category. Motivation behind including the power OH cost category in the mission execution activity cost pool is two-fold. First, the HFC generator is available for mission use. The second motivation is the added value of having the generators as a redundant power source (assuming that resources external to the Nemesis organization provide power for the NetWarVan). The MNOC accommodations activity cost pool provides usage for the vehicle and the power OH cost categories. Inclusion of the vehicle OH cost category in the MNOC accommodation activity cost pool is due to increased wear and tear from berthing requirements. The reason for inclusion of the power OH cost category is the same as the reason that the power OH cost category was included in the mission execution OH cost category.

The power generation activity cost pool provides usage solely for the power OH cost category. The power generation activity cost pool is the primary activity cost pool

for the power OH cost category. The power generation activity cost pool is applicable for missions where the primary source of power for the NetWarVan is *not* provided by resources external to the Nemesis organization. If an externally provided power source is unavailable for short periods of time, the mission will not incur power generation OH costs. The program manager makes the determination of what constitutes short periods of time on a case-by-case base.

The five activity cost pools form a basis that covers practically all vehicle, power, and technical equipment OH costs. The program manager based on historical data and his expertise determines the appropriate percentage of each OH cost category for each activity cost pool. The division of OH cost categories into five activity cost pools is summarized in Table 20. Mission-cost drivers, determined in the previous section, are used to allocate the proportional OH cost to each mission.

Table 20. OH cost category summary.

	Transport	**Setup**	**Mission Execution**	**RV Accommodations**	**Power Generation**
Vehicle[1]	75%	5%	10%	10%	-
Power[2]	-	-	15%	15%	70%
Tech Equip[3]	5%	10%	85%		

[1] RV lifecycle, maintenance, repair, storage cost included in OH cost.

[2] Gas and HFC generators life cycle, maintenance and repair included in OH cost.

[3] Network, Radio (communications), Antenna, Software included in technical equipment.

The final component of the OH allocation process is to assign cost drivers to activity cost pools. The proper assignment of drivers to cost pools allows for a proportionate allocation of OH to a mission. Based on the description of the activity cost pools, the following mission-cost drivers are assigned to the activity cost pools:

Activity cost pool	Cost Drivers
Transporting	Distance (miles)
Physical Mission Setup	Mission site set up (Once per mission[1])
Mission Execution	Mission Duration (days)
RV Accommodations	Mission Duration (days)
Power Generation	Per shift[2]

[1] This can be used to wrap multiple missions into one if the missions are near in time and distance.

[2] Shift 1 during mission execution. Shift 2 used if no accommodations are available.

Predetermined OH rates (POHR) are generated using activity driver data from Table 18, annual cost category OH data from Table 19, and percentage distributions of OH cost categories amongst activity cost pools listed in Table 20. POHR associated with respective OH cost categories and activity cost pools are presented in Table 21. Taking the proportional annual OH cost category amount, based on activity, and dividing it by the total number of units within the assigned cost driver combine data from Tables 18 – 20. The same concept is presented below in equation form:

Cost / driver = OH cost category $ amount x (Table 20 %) / **(**annual driver totals)

Using the results in Table 21, most of the associated OH cost can be assigned to a specific mission based on the cost drivers.

Table 21. POHR for associated OH cost categories and activity cost pools.

	Transportation (per mile)	**Setup (per setup)**	**Mission Execution (per day)**	**RV Accommodations. (per day)**	**Power Generation (per shift)**
Vehicle	$0.94	$13.29	$4.78	$13.71	-
Power	-	-	1.43	4.11	18.59
Tech Equip	0.64	270.67	413.61	-	-
Total	1.57	283.96	419.82	17.83	18.59

D. PERIOD COSTS

Additional program costs that have not been included thus far, yet continue to be incurred, are classified as period costs. Elements from all cost types are classified as period costs. A list of costs that are not fully included thus far are infrastructure costs (lab, MNOC storage, and intellectual), travel costs (PM and training), labor (some PM, some technicians, and some non-billed), and equipment (misc. equipment and consumables). In previous sections, costs were associated with missions as a function of activity within the mission. This method of costing reflects most of the actual costs of the mission. However, this method is not well adapted to assigning all program costs to missions. One way to use this method with period costs would be to lump all the period costs together and then divide that amount by the number of missions and assign the result to each mission. This method of costing is described as the "equal shares" method. A disadvantage of the equal shares method is that it unduly burdens the shorter, less expensive missions with a disproportionate allotment of the period cost.

An alternate method for assigning period costs to missions would be to spread the period costs evenly across all missions with respect to the total cost of the missions. This method of costing is described as the price distribution method. The price distribution method would more accurately distribute the cost. The attractiveness of this method quickly vanishes in light of the complex requirement that exists that would require that the cost for each and every mission to be estimated in order to implement this method. Although a price distribution method that uses a less inclusive total mission cost could be adopted, it would also highlight another weakness of the price distribution method. This additional weakness is that economies of scale for longer missions cannot be fully realized to accurately reflect the savings due to a longer mission.

Following the model of the Federal Government’s Bicameral Legislative branch, as described in the Constitution of the United States of America, a compromise between the two methods was developed. This is the same compromise we have made in this case by combining both methods into a single system. This produces a lever that allows the program manager to determine the percentage of each method to be applied. This allows

the PM to control the weighting of each method. The initial setting used for mission costing is an equally balanced setting such that each approach determines exactly half of the period cost to the missions.

Implementing the equal shares method within the period costing system is very simple. Since half of the period cost is attributed using the equal shares method, half of the period cost is divided by the number of projected annual missions, 32, and the resulting costs are assigned to each mission. For the resulting period cost, listed in Table 22, the equal shares method applies $1,355 per mission given that the weighting methods are balanced. Although the price distribution method is more complex, it is simplified so that the costing is more manageable. The simplification of the price distribution method is that only OH cost categories are included in determining what the cost of all of the missions are projected to be. This is a reasonable constraint since mission costs such as manning, fuel, per diem, etc. are highly variable. Therefore projections would be subject to gross inaccuracy, and this is less than desirable since the constraints include a significant portion of the cost for all the missions. This constraint also allows the period cost to mission cost allocation based solely on the mission profile projections in Tables 15 and 17 as well as the POHR in Table 21. The details of how the price distribution method is used to allocate the period cost to the primary mission locations are shown in Table 22. A strength of the period cost allocation method is that the program manager can adjust the allocation to fit the program's changing needs.

Data from this chapter provides guidelines to both estimate and cost a NetWarVan mission. The mission costing work sheet summarizes the approach to mission costing (see Appendix G). Also, the mission costing worksheet integrates results from this costing chapter into a document that is contained on a single sheet of paper (doubled sided). This chapter provides a firm foundation for costing missions or a basis from which more detailed costing can be accomplished.

Table 22. Period cost applied to mission location, using the price distribution method, with equally balanced weights.

	Annual Cost	**Big Sur**	**Camp Roberts[1]**	**San Diego**	**Seattle**
Cost Factor	-	0.0067	0.0185	0.0411	0.0486
Lab	$6,840	$45.80	$126.22	$280.89	$332.49
RV storage	240	1.61	4.43	9.86	11.67
Intellectual	495	3.31	9.13	20.33	24.06
PM Travel	479	3.21	8.84	19.67	23.28
Training	3,068	20.54	56.61	125.99	149.13
Misc. Equip	300	2.01	5.54	12.32	14.58
Consumables	300	2.01	5.54	12.32	14.58
Labor PM	30,000	200.86	553.59	1,231.95	1,458.28
Labor Tech (75% at nps)	45,000	100.43	276.79	615.98	729.14
Labor non-billed	0.00	0.00	0.00	0.00	0.00
Total Price Dist	86,722	580	1,600	3,561	4,215
Total Period Cost Allocation		$1,935.65	$2,955.30	$4,916.28	$5,570.53

[1] Mission duration is averaged so that a single cost can be assigned to the location.

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IV. BUDGETING

A. BUDGET BACKGROUND AND JUSTIFICATION

Firms or business units typically use operating budgets. They will propose a budget before the year begins, carry out the years activities, then compare their proposal with what actually takes place. Analysis of the variances between the proposed budget and what actually takes place equips a firm to more accurately predict future operating budgets and or to trim areas of waste. Nemesis needs an operating budget, but for similar yet different reasons since it is a research program.

The Nemesis program's operating budget proposal is used as a mechanism to track expenses and validate funding requests from ongoing and potential funding sources. Ongoing funding sources include CDTEMS, NIWA, Navy CIO, and NAVSECGRU. The projected operating budget provides an outline for funding requests. Funding request are prepared prior to the end of the fiscal year and are used to provide an accurate estimate of the upcoming year's funding requirement.

Although the Nemesis program has been in operation for over a year, it has not been operational for an entire year. All money related to Nemesis obligated at the end of 2002 and during 2003 is related to original cost; therefore, there was no purpose in having an operating budget during the program startup phase.

Now that Nemesis is operational, operating budgets are useful and the first of these will be proposed herein. As indicated above, Nemesis' proposed operating budget is used as justification for annual funding requests. The largest portion of the funding consists of labor and equipment. Labor costs consist of program manager and government service (GS) employee/Contractor labor. Equipment costs are determined by the annual life cycle costs associated with technology turnover, per Chapter Three.

There are three funding cost types in the operating budget: fixed costs, variable costs, development (improvement) costs. Non-billed labor and infrastructure do not require funding requests and so are excluded from the budget. After fixed, variable, and development cost types are defined, a proposed budget is provided for the next seven

years, based on projected operating tempo and mission mix. Some of the variables in the mission mix are number of operators per mission, location, and lodging requirements.

B. FIXED COST

Fixed cost is a cost that the Nemesis program will incur regardless of the number of missions conducted or miles driven. The following is a list of fixed costs subcategories with a brief explanation of each:

-*Life cycle:* The life cycle category is composed of vehicle, equipment, and power. The annual fixed cost for each of these is derived from original cost and a straight line cost distribution. Original cost for each item is divided by the number of useful/relevant years the Nemesis program expects to receive from each item. For example, if a device is expected to be relevant to the program for one year, it will included in the total cost to replace this item in the next year's proposed budget request. For items that are expected to be relevant for more than one year the funding request to replace the item will not appear until the end of the relevant use of the item. The equipment is then replaced with the funding received at the beginning of the year immediately following the last year of item relevance.

-*External Services:* This fixed cost category consists of services such as digital subscriber line (DSL) in the lab and satellite internet service in the NetWarVan. These costs are not expected to change dramatically since any decrease in cost will likely be offset by an increase in service capability.

-*Labor:* The labor category consists of the Nemesis program manager's labor. Also included in the labor cost category is any part time or full time labor acquired to support Nemesis whether the labor is in the form of a contractor or a GS employee.

-*Support:* The support category includes additional repairs for damage or breakdowns. Although estimates for annual maintenance and repairs are included, additional costs are expected. The additional costs are expected because the maintenance/repair rates are associated with personal RV use, whereas the NetWarVan will have many unfamiliar users and the use of the NetWarVan will be considerably more arduous than an average RV user would. The additional cost also offsets the repairs

covered by insurance since the government is self-insured. This means that if the vehicle is damaged, the program funding will pay for the repairs in full.

C. VARIABLE COST

Variable cost is a cost that correlates to the amount the NetWarVan is used. The variable cost is only relevant over a certain range of operating days and or miles logged by the NetWarVan. As an example if the annual distance traveled by the NetWarVan was much higher i.e., 20,000 miles, then additional costs would be incurred. The additional cost would be due to the reduction in the life of the NetWarVan. The following is a list of variable cost categories with brief explanations:

-*Travel:* The travel cost consists of per diem and lodging expenses. The overall cost associated with travel costs vary with the number of days traveled, the number of personnel, the mission location, and whether lodging is required or even available.

-*Training:* This cost is associated with training costs that directly benefit the Nemesis program. Network related certifications would be included in this category.

-*Excess bandwidth:* Mobile satellite internet access is included in fixed costs for use equal to or less than sixty minutes per month. Above sixty minutes of connectivity per month, there is an additional per minute charge.

-*Consumables:* Consumables include items such as gasoline, oil, and toilet paper.

-*Thesis work:* This category uses funds to generate interest and realize additional thesis work, above and beyond what is expected of the program manager. The idea here is to provide funding to encourage participation from additional professors, faculty, and students in the Nemesis program. This funding would encourage further interdisciplinary work that leverages the NetWarVan capabilities. A possible approach to distributing the funding could be modeled after the fellowships currently provided to NPS by Space and Naval Warfare Systems Command (SPAWAR). SPAWAR screens fellowship applications and then awards the best projects with $10,000 annual fellowships awarded to students and advisors to conduct research. An alternate approach that could be used to determine the funding needed to generate interdisciplinary faculty interest is to consider the external faculty-billing rate. An approximate range of external faculty billing is

$16,000 to $20,000 per month. The number of thesis' written and the amount of research produced based on one month of faculty labor is highly variable.

D. DEVELOPMENT COST

The Nemesis program is a research venture. The primary element of the Nemesis program, the NetWarVan, is a dynamic research tool whose usefulness began with the proof of concept. The NetWarVan's capabilities should constantly evolve so that it embodies the cutting edge technology that is essential to research and development. The Nemesis program's support of developing wireless applications that provides infrastructure for military, DoD, and other government agencies requires that the NetWarVan be supported by talented motivated personnel and the most current wireless technology. To this end the annual operating budget includes funding to acquire critical new technologies for research. This additional funding will aid in maintaining the Nemesis program's cutting edge advantage. The following are the development categories and brief explanations of each category.

-*Development costs:* These are funds requested above and beyond fixed and variable costs to maintain the Nemesis program's lead in wireless technological research.

-*Maximum Operating Tempo*: The NetWarVan is limited in the number of missions that it can execute per year based on various factors such as operating days or miles traveled. It is estimated that the NetWarVan can conduct a maximum of 40-45 missions in one year. The maximum operating tempo is based on program manager estimations. These 40-45 missions are a combination of local and out-of-area missions. Based on the projected maximum number of missions, if the anticipated need for the NetWarVan is close to or is expected to exceed the projected maximum operating tempo, additional funds would be requested to produce a second NetWarVan. The replicating cost from Chapter Two could be used as a metric from which to estimate requested funding.

E. PROPOSED BUDGET

The proposed budget is a tool to determine the level of funding that should be requested. The line items used in the variable costs section of the budget are dependent

on the predicted operating tempo and mission mix. Items such as the number of missions, funded operators per mission, and local vs. out-of-area missions had to be estimated. Future budgets will use corrected estimations based on historical data and missions that are scheduled for the upcoming year. Using this approach, the projected budgets for years one through seven (2004-2010) of operations have been generated, as shown in Table 23. The reason that the budgets are projected for seven years is that this corresponds to the longest equipment life cycle. The vehicle, generators, and communications equipment are capital expenses that have a life cycle of seven years. This period of budget projection is not an indication of the potential life of the program but rather it is a projection of the life cycle of a significant part of the equipment associated with the present NetWarVan. The seven-year projection should be updated annually to more accurately reflect the budgeting needs of the program. The operating tempo that these budgets are based on is 32 missions per year, just as in the mission-costing chapter. Additional metrics for the budget are indicated below the budget. All elements of the budget have been adjusted by 2 percent a year to account for inflation. This inflation offset is congruent with inflation rates of the last few years and is in line with the program manager's expectations. The following two pages show the seven-year budget projection of the Nemesis program.

Infrastructure or non-billed labor costs are not included in the budget. Although these costs are estimated in Chapters Two and Three, they were not included since these costs are funded by NPS. The fact that NPS bears these costs without requiring reimbursement from funding agencies highlights an economic advantage of continuing the Nemesis program at its present location. Additionally the proposed budget is a tool to determine the level of funding that should be requested. This primary purpose for the budget is the reason that the averaged mission costing life cycle cost (approximately $92,000 per year) is not used. Using the average life cycle cost would show the cost used in the year, but it would not provide the necessary information needed to project funding requirements.

Table 23. Operating Budget projection for the first 7 years of operation.

Fixed Costs:(#s in thousands**)**	2004	2005	2006	2007	2008	2009	2010
Life cycle	$.4	$126	$35	$148	$14.5	$152	$147
Service costs							
DSL($85/month)	1	1	1	1.1	1.1	1.1	1.1
Satellite Internet($276/month)	3.3	3.4	3.4	3.5	3.6	3.7	3.7
Service costs Total:	*4.3*	*4.4*	*4.4*	*4.6*	*4.7*	*4.8*	*4.9*
Labor							
PM (25% of yearly salary)	45	45.9	46.8	47.7	48.7	49.7	50.8
GS/Contractor	24	24.5	25	25.5	26.1	26.6	27
Labor Total:	*69*	*70.4*	*71.8*	*73.2*	*74.8*	*76.3*	*77.8*
Support							
Maint/support	1	1	1	1.1	1.1	1.1	1.1
Miscellaneous	1.5	1.5	1.6	1.6	1.6	1.7	1.7
Support Total:	*2.5*	*2.5*	*2.6*	*2.7*	*2.7*	*2.8*	*2.8*
Fixed Costs Total: 76.2	***203.3***	***113.8***	***228.5***	***96.7***	***235.9***	***232.5***	
Variable Costs:							
Travel[2]							
Lodging	23	23.5	24	24.5	25	25.5	26
Per Diem	20	20.4	20.8	21.2	21.6	22.1	22.5
Travel Total:	*43*	*43.9*	*44.8*	*45.7*	*46.6*	*47.6*	*48.5*
Training	10	10.2	10.4	10.6	10.8	11	11.3
Excess bandwidth use[3]	.6	.6	.6	.6	.7	.7	.7
Consumables							
Gas[4]	1.6	1.6	1.7	1.7	1.7	1.8	1.8
Miscellaneous	2	2	2.1	2.1	2.2	2.2	2.3
Consumables Total:	*3.6*	*3.6*	*3.8*	*3.8*	*3.9*	*4*	*4.1*
Thesis Work[5]							
Fellowship	50	51	52	53	54	55.2	56.3
Variable Costs Total:	***107.2***	***108.4***	***110.8***	***113.7***	***115.2***	***117.5***	***120.6***

Table 23. Operating Budget projection for the first 7 years of operation. Fiscal Year Budget Projection[1]Continued (cont.)

Development Costs:							
Technical Capabilities	30	30.6	31.2	31.8	32.5	33.1	33.8
Increased operating tempo							
Second NetWarVan[6]	345	351.9	359	366.1	373.4	381	389
Total Development:	***375***	***382.5***	***390.2***	***397.9***	***405.9***	***414.1***	***422.8***
Total w/o 2nd NetWarVan[7]:	**558.4**	**694.2**	**614.8**	**740.1**	**617.8**	**767.5**	**774.9**
Total w/ second NetWarVan[8]:	**184.5**	**343**	**257**	**375.1**	**246.6**	**387.6**	**386.1**

Notes:

[1] Budget based on 32 missions/year, the work done in the previous chapters and best estimates of the program manager.

[2] Assumes an average of 3 personnel on travel, paying for lodging 50% of the time, at the Camp Roberts, CA rate for per diem and lodging. Lodging = 95*3*$79.00 = $22,515. Per diem: 190*3*$35.00 = $19,950. Total = $42,465.

[3] Based on 60 minutes per month fixed and each additional minute costing .79 cents and using an additional 60 minutes per month.

[4] Based on annual estimations of 6,820 miles from chapter 2 with gas at $1.60 per gallon and averaging 7 miles per gallon = $1,559.

[5] Assuming 5 thesis fellowships at $10,000 each.

[6] Replicating costs from Ch. 3 are $439k, however, NPS would realize roughly $94k reduction in cost (PM labor and travel costs) due to familiarity, etc.

[7] Based on needing to conduct 45 or more missions per year and therefore needing to purchase a second NetWarVan.

[8] Mission numbers are expected to be less than 45 which will not require a second NetWarVan.

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V. CONCLUSION AND RECOMMENDATIONS

A. CONCLUSION AND SUMMARY

Determining original costs for the Nemesis program is an important part of the overall viability of the program. It allows for a consolidated, accurate record of the program's cost. This record will be used as a tool to establish funding levels needed to re-capitalize the major costs associated with the program. Work related to original cost also highlights the benefit of developing the NetWarVan as an operational Mobile Network Operations Center in a research environment by realizing the reduced cost for development. This reduced cost is realized primarily through leveraging infrastructure at NPS and reduced labor costs via non-billed labor (student thesis and course work).

Since useful products and programs are often replicated, an estimated cost for replicating the process was determined. In light of requests for replicating information it is expected that DoD, federal agencies, and commercial firms will be interested in creating additional MNOC platforms. The replicating information provides a good estimation of the cost and the associated equipment lists provide a fairly complete acquisition guide. Using the replicating resources will reduce the effort and resources required to replicate the NetWarVan since cost estimation, acquisition guidance, and operating guidance is available.

The Nemesis program personnel are aware of costs related to general operations. Determining a more accurate approximation of the cost associated with general operations requires a comprehensive method of tracking and allocating costs. This research project provides operating costs based on the original cost of Nemesis program equipment spread over each item’s useful life, along with labor, and variable costs established using 2004’s expected operating tempo. Using the mission-costing template, in appendix G, mission costing is straightforward. If the operating tempo is expected to deviate significantly from the established baseline of 32 missions, it would be necessary to rescale the exact costing numbers. The level of accuracy desired along with the remaining mission mix determines what a significant deviation from the baseline of 32

missions would be. The overhead cost category is directly affected by the operating tempo.

Based on the nature of the Nemesis program, knowing what it costs to operate is of great value to internal and external stakeholders of the project. However, because this is a DoD research project, there is additional information that is vital to the program. The additional information is required because, as a DoD research project, Nemesis is funded for some time frame based on projected needs. What this means, for instance, is that the program cannot receive money today for replacement of the MNOC in anticipation of replacing it at the end of its seven-year useful life. In other words a DoD entity cannot have capital accumulating in anticipation of future needs. Taking this into account, the budget in Chapter IV provides a seven-year plan used to request funds to re-capitalize equipment that is at the end of its life cycle. These life cycle numbers are based on equipment depreciation schedules that are combined with expected technology roll over of research equipment.

B. CONTRIBUTIONS TO DOD

DoD has been using wireless communications for hundreds of years (e.g. signal flags, radio, etc.) It is expected that DoD will continue to exploit the benefits of the wireless communications spectrum into the foreseeable future and beyond. The research being conducted by the Nemesis program is extremely valuable in securing the offensive and defensive roles of wireless and free space optics for the military and civilian applications. The financial analysis of the Nemesis project enables the development of a fiscally responsible strategy for the use and replication of the NetWarVan.

The financial analysis of the Nemesis program generated an original cost, a replicating cost, a mission costing approach, and an operating budget. The original cost provided a gauge by which to measure the financial cost of evaluating the Nemesis proof of concept, producing the NetWarVan, and documenting the research results. The replicating cost analysis will allow DoD, or other authorized organizations, to realize significantly reduced efforts and costs to undertake similar MNOC projects using the cost

estimates to request funding, the equipment lists as an acquisition guide, and the operating procedures as an operational guide. The mission costing provides the program manager with the tools to estimate mission costs. This mission costing provides the fiscal impact of research efforts. Budgeting provides the program manager and funding organizations a clearer picture of projected costs that will be necessary to maintain, develop capabilities, and increase the operating tempo of the Nemesis program.

As a more general contribution, the financial analysis process used in this report could be applied to assist the costing of research projects that are transitioning from basic research to implementation stages. The labor models, original cost compartmentalization approach, mission costing methods and metrics, and budget projection parameterization are excellent examples of financial management tools for managers of research projects. These tools can be used in the financial analysis of a wide variety of research projects moving to the first stages of implementation.

C. LIMITATIONS

The financial analysis provided introduced the artificiality of all equipment being purchased at the beginning of the fiscal year it was purchased in and that equipment expires at the end of a year. Not all equipment was purchased at the beginning of the fiscal year nor will it expire at the end of any given year. In addition to the purchase date of equipment not being included, the entire accounting process was not automated. Portions of the analysis were automated in Excel. The sections of the financial analysis that were automated were not fully standardized and documented. This lack of standardization and documentation could inhibit inexperienced and unfamiliar personnel from correctly using the automated financial analysis tools.

D. FUTURE WORK

This research project provides costing information for the Nemesis project that is relevant for the development of the NetWarVan, is relevant for the first year of its operating life (FY 2004), and is relevant for replication of an MNOC for at least a year.

Because it is impossible to anticipate what will occur from a wireless and free space optics technology perspective in the next 2 to 6 years, this information will need to be revisited frequently to guarantee its relevance. Suggested future research project work that is directed at maintaining the relevance of the financial analysis tools and metrics are presented below.

A relational database would be useful to track and automate the financial analysis that is being used. The database would further equip the Nemesis program manager and the research assistants with a tool to financially manage the program. One of the primary advantages of using a database is that life cycle costs could be automatically tracked with respect to acquisition date. This approach would provide greater accuracy since items purchased at the end of the year would require funding nearly 12 months later than the present system accounts for it. The use of a relational database would provide greater accuracy in determining the annual operating costs as well as individual mission costs, and allow for dynamic cost allocation based on date purchased and life cycle expiration. Additionally the relational database would allow for convenient operational tempo, resource, and costing rate adjustments as well as a tracking mechanism for the program manager and funding agencies.

Integration of the equipment spreadsheet in Appendix A and the current Nemesis inventory is another area of future research project work. These documents are separate, stand-alone spreadsheets that need to be combined. Once combined, this single source equipment inventory can be incorporated into the above-mentioned relational database. The Nemesis program has recently purchased a bar code reader and inventory software, and if the inventory were entered into a relational database, distribution and inventories of equipment would be more automated.

Future research project work should include a comparison of the methods developed in this report and the actual operation costs over a period of time. This comparison would either validate the methods used or provide guidance to further modify the method of predicting funding required. From this compare and correct approach, the accuracy of funding requests may be improved.

APPENDIX A-ACCOUNTING DATA

This appendix was to include the equipment list for the Nemesis project however, it has been removed due to security concerns.

DESTINATION	PURPOSE	PER DIEM EST	AIRFARE EST	COST EST	COST FINAL	Travel Classification
Salinas, CA	Pick up parts	$18.00		$18.00	$18.00	Acqu/Training
Salinas, CA	Pick up parts	$18.00		$18.00	$18.00	Acqu/Training
Salinas, CA	Pick up parts	$18.00		$18.00	$18.00	Acqu/Training
Santa Cruz, CA	Mission	$385.00		$385.00	$165.40	Prog. Mang.
Camp Roberts, CA	Site Survey	$214.00		$214.00	$105.55	Acqu/Training
Camp Roberts, CA	Site Survey	$152.00		$152.00	$31.50	Acqu/Training
Camp Roberts, CA	Mission	$313.00		$313.00	$313.80	Prog. Mang.
Camp Roberts, CA	Site Survey	$142.00		$142.00	$63.00	Testing
Camp Roberts, CA	Site Survey	$213.28		$213.28	$134.28	Testing
Camp Roberts, CA	Site Survey	$213.28		$213.28	$63.00	Testing
Camp Roberts, CA	Site Survey	$220.48		$220.48	$134.28	Testing
Camp Roberts, CA	Cancelled	$152.00	($152.00)	$0.00	$0.00	Testing
Camp Roberts, CA	Site Survey	$222.56		$222.56	$63.00	Testing
San Luis Obispo, CA	Mission	$212.56		$212.56	$134.28	Testing
San Luis Obispo, CA	Mission	$142.00		$142.00	$63.00	Testing
San Luis Obispo, CA	Mission	$212.56		$212.56	$133.56	Testing
San Luis Obispo, CA	Mission	$142.00		$142.00	$63.00	Testing
San Diego, CA	Net Sec Class	$271.00		$271.00	$283.50	Acqu/Training
San Diego, CA	Net Sec Class	$271.00		$271.00	$271.00	Acqu/Training
Monterey	Speaker IS/IW	$503.00		$503.00	$503.00	Acqu/Training
Colorodo Springs, CO	Speaker IS/IW	$300.00	$620.00	$920.00	$920.00	Acqu/Training
send to MS 8/19		$500.00	$400.00	$900.00	$900.00	Acqu/Training

Acqu/Training	$3,068.55
Prog. Mang.	$479.20
Testing	$851.40
Total	$4,399.15

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APPENDIX B-WORK SURVEY

NEMESIS PROJECT WORK SURVEY

1. **Course(s)** taken in direct support of NEMESIS. Course # ____ ____ ____

Quarter (i.e. Sm 03) ____ ____ ____

Lecture hrs ____ ____ ____

Lab hrs ____ ____ ____

2. Hours outside of class lecture that directly supported NEMESIS.

Quarter (i.e. Sm 03) ____ ____ ____

Hours (per week) ____ ____ ____

3. From the hours provided in question 2 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, manual labor, and administrative)?

Quarter (i.e. Sm 03) ____ ____ ____

Learning (that did **not** directly develop NEMESIS, hrs per week) ____ ____ ____

Technical Labor (Primarily network related work, hrs per week) ____ ____ ____

Manual Labor (hrs per week) ____ ____ ____

Administrative Labor (Acquisition, inventory, etc, hrs per week) ____ ____ ____

Other (Please describe_____, hrs per week) ____ ____ ____

4. **Directed studies** taken in direct support of NEMESIS that is/are **not** listed above.

Quarter (i.e. Sm 03) ____ ____ ____

Hours (per week) ____ ____ ____

5. From the hours provided in question 4 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, and manual labor)?

Quarter (i.e. Sm 03) ____ ____ ___

Learning (that did **not** directly develop NEMESIS, hrs per week) ____ ____ ____

Technical Labor (Primarily network related work, hrs per week) ____ ____ ____

Manual Labor (hrs per week) ____ ____ ____

Administrative Labor (Acquisition, inventory, etc, hrs per week) ____ ____ ____

Other (Please describe_____, hrs per week) ____ ____ ____

6. **Thesis** work that directly benefited the NEMESIS project.

Quarter (i.e. Sm 03)	____	____	____
Hours (per week)	____	____	____

7. From the hours provided in question 6 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, and manual labor)?

Quarter (i.e. Sm 03)	____	____	____
Learning (that did **not** directly develop NEMESIS, hrs per week)	____	____	____
Technical Labor (Primarily network related work, hrs per week)	____	____	____
Manual Labor (hrs per week)	____	____	____
Administrative Labor (Acquisition, inventory, etc, hrs per week)	____	____	____
Other (Please describe_____, hrs per week)	____	____	____

8. **Additional** work related to NEMESIS not captured above.

Quarter (i.e. Sm 03)	____	____	____
Learning (that did **not** directly develop NEMESIS, hrs per week)	____	____	____
Technical Labor (Primarily network related work, hrs per week)	____	____	____
Manual Labor (hrs per week)	____	____	____
Administrative Labor (Acquisition, inventory, etc, hrs per week)	____	____	____
Other (Please describe_____, hrs per week)	____	____	____

9. Additional comments or information._____

_____

_____

_____

_____

Dwayne ~~Duane~~ Lancaster.

NEMESIS PROJECT WORK SURVEY

1. **Course(s)** taken in direct support of NEMESIS. Course # IS4925

   Quarter Summer 03

   Lecture hrs 2

   Lab hrs 2

2. Hours outside of class lecture that directly supported NEMESIS.

   Quarter 120

   Hours (per week) 8

   ASC After survey comment 12 week quarters should be 10 hrs/wk not 8

3. From the hours provided in question 2 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, manual labor, and administrative)?

   Quarter Summer 03

   ASC After survey comment included in additional work category

   Learning (that did **not** directly develop NEMESIS, hrs per week) 40 (1 week TAD)

   Technical Labor (Primarily network related work, hrs per week) 8

   Manual Labor (hrs per week) 2

   Administrative Labor (Acquisition, inventory, etc, hrs per week) ___

   Other (Please describe_____, hrs per week) ___

4. **Directed studies** taken in direct support of NEMESIS that is/~~are~~ **not** listed above.

   Quarter ___

   Hours ___

5. From the hours provided in question 4 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, and manual labor)?

   Quarter ___

   Learning (that did **not** directly develop NEMESIS, hrs per week) ___

   Technical Labor (Primarily network related work, hrs per week) ___

   Manual Labor (hrs per week) ___

   Administrative Labor (Acquisition, inventory, etc, hrs per week) ___

   Other (Please describe_____, hrs per week) ___

6. **Thesis** work that directly benefited the NEMESIS project.

Quarter None to date

Hours (per week) ___ ___ ___

7. From the hours provided in question 6 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, and manual labor)?

Quarter ___ ___ ___

Learning (that did **not** directly develop NEMESIS, hrs per week) ___ ___ ___

Technical Labor (Primarily network related work, hrs per week) ___ ___ ___

Manual Labor (hrs per week) ___ ___ ___

Administrative Labor (Acquisition, inventory, etc, hrs per week) ___ ___ ___

Other (Please describe_____, hrs per week) ___ ___ ___

8. **Additional** work related to NEMESIS not captured above.

Quarter ___ ___ ___

Learning (that did **not** directly develop NEMESIS, hrs per week) ___ ___ ___

Technical Labor (Primarily network related work, hrs per week) ___ ___ ___

Manual Labor (hrs per week) ___ ___ ___

Administrative Labor (Acquisition, inventory, etc, hrs per week) ___ ___ ___

Other (Please describe_____, hrs per week) ___ ___ ___

9. Additional comments or information._____

_____

_____

_____

_____

Carl

NEMESIS PROJECT WORK SURVEY

1. **Course(s)** taken in direct support of NEMESIS. Course # IS4925___

Quarter (i.e. Sm 03) _03-4___

Lecture hrs _2 _ ____

Lab hrs ___1 ____ ____

2. Hours outside of class lecture that directly supported NEMESIS.

Quarter (i.e. Sm 03) __03-4_ ____

Hours (per week) _3 ____ ____

3. From the hours provided in question 2 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, manual labor, and administrative)?

Quarter (i.e. Sm 03) 03-4__ ____ ___

Learning (that did **not** directly develop NEMESIS, hrs per week) ___2.5_ ____ ____

Technical Labor (Primarily network related work, hrs per week) ____ ____ ____

Manual Labor (hrs per week) __0.5__ ____ ____

Administrative Labor (Acquisition, inventory, etc, hrs per week) ____ ____ ____

Other (Please describe_____, hrs per week) ____ ____ ____

4. **Directed studies** taken in direct support of NEMESIS that is/are **not** listed above.

Quarter (i.e. Sm 03) ____ ____ ____

Hours ____ ____ ____

5. From the hours provided in question 4 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, and manual labor)?

Quarter ____ ____ ___

Learning (that did **not** directly develop NEMESIS, hrs per week) ____ ____ ____

Technical Labor (Primarily network related work, hrs per week) ____ ____ ____

Manual Labor (hrs per week) ____ ____ ____

Administrative Labor (Acquisition, inventory, etc, hrs per week) ____ ____ ____

Other (Please describe_____, hrs per week) ____ ____ ____

6. **Thesis** work that directly benefited the NEMESIS project.

Quarter (i.e. Sm 03) _03-4 ____ ____

Hours (per week) __3__ ____ A SC 2 hours 1 week

7. From the hours provided in question 6 provide a **break down into type**, i.e. what portion was directly related to the following

Quarter (i.e. Sm 03)___ ____

Manual Labor (hrs per week) ____ ____ ____

Administrative Labor (Acquisition, inventory, etc, hrs per week) ____ ____ ____

Other (Please describe_____, hrs per week) ____ ____ ____

8. **Additional** work related to NEMESIS not captured above.

Quarter (i.e. Sm 03) ____ ____ ____

Learning (that did **not** directly develop NEMESIS, hrs per week) ____ ____ ____

Technical Labor (Primarily network related work, hrs per week) ____ ____ ____

Manual Labor (hrs per week) ____ ____ ____

Administrative Labor (Acquisition, inventory, etc, hrs per week) ____ ____ ____

Other (Please describe_____, hrs per week) ____ ____ ____

9. Additional comments or information._____

_____Primarily used Nemesis as a research platform to conduct a thesis which is on a tight schedule. Most time went into learning and preparing equipment for an experiment. Indirectly contributes to Nemesis' capability set.

Chris

NEMESIS PROJECT WORK SURVEY

1. **Course(s)** taken in direct support of NEMESIS. Course # NS 4925 Directed Study

   Quarter Summer

   Lecture hrs 2

   Lab hrs 2

2. Hours outside of class lecture that directly supported NEMESIS.

   Quarter 4/03

   Hours (per week) 16 6

3. From the hours provided in question 2 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, manual labor, and administrative)?

   Quarter

   Learning (that did **not** directly develop NEMESIS, hrs per week)

   Technical Labor (Primarily network related work, hrs per week) 4

   Manual Labor (hrs per week) 1

   Administrative Labor (Acquisition, inventory, etc, hrs per week) 1

   Other (Please describe_____, hrs per week)

4. **Directed studies** taken in direct support of NEMESIS that is/are **not** listed above.

   Quarter

   Hours

5. From the hours provided in question 4 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, and manual labor)?

   Quarter

   Learning (that did **not** directly develop NEMESIS, hrs per week)

   Technical Labor (Primarily network related work, hrs per week)

   Manual Labor (hrs per week)

   Administrative Labor (Acquisition, inventory, etc, hrs per week)

   Other (Please describe_____, hrs per week)

6. **Thesis** work that directly benefited the NEMESIS project.

None to date

Quarter ___ ___ ___

Hours (per week) ___ ___ ___

7. From the hours provided in question 6 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, and manual labor)?

Quarter ___ ___ ___

Learning (that did **not** directly develop NEMESIS, hrs per week) ___ ___ ___

Technical Labor (Primarily network related work, hrs per week) ___ ___ ___

Manual Labor (hrs per week) ___ ___ ___

Administrative Labor (Acquisition, inventory, etc, hrs per week) ___ ___ ___

Other (Please describe_____, hrs per week) ___ ___ ___

8. **Additional** work related to NEMESIS not captured above.

Quarter ___ ___ ___

Learning (that did **not** directly develop NEMESIS, hrs per week) ___ ___ ___

Technical Labor (Primarily network related work, hrs per week) ___ ___ ___

Manual Labor (hrs per week) ___ ___ ___

Administrative Labor (Acquisition, inventory, etc, hrs per week) ___ ___ ___

Other (Please describe_____, hrs per week) ___ ___ ___

9. Additional comments or information._____

_____

_____

_____

_____

NEMESIS PROJECT WORK SURVEY

1. **Course(s)** taken in direct support of NEMESIS. Course # IS 4 9 2 5

   Quarter Summer 03 (03-4)

   Lecture hrs 2 ___ ___

   Lab hrs 2 ___ ___

2. Hours outside of class lecture that directly supported NEMESIS.

   Quarter 03-4 ___ ___

   Hours (per week) 8-10 ___ ___ A s c means takes

3. From the hours provided in question 2 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, manual labor, and administrative)?

   Quarter 03-4 ___ ___

   Learning (that did **not** directly develop NEMESIS, hrs per week) 1-2 ___ ___

   Technical Labor (Primarily network related work, hrs per week) 1-2 ___ ___

   Manual Labor (hrs per week) 1-2 ___ ___

   Administrative Labor (Acquisition, inventory, etc, hrs per week) 3-4 ___ ___

   Other (Please describe_____, hrs per week) ___ ___ ___

4. **Directed studies** taken in direct support of NEMESIS that is/are **not** listed above.

   Quarter ___ ___ ___

   Hours ___ ___ ___

5. From the hours provided in question 4 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, and manual labor)?

   Quarter ___ ___ ___

   Learning (that did **not** directly develop NEMESIS, hrs per week) ___ ___ ___

   Technical Labor (Primarily network related work, hrs per week) ___ ___ ___

   Manual Labor (hrs per week) ___ ___ ___

   Administrative Labor (Acquisition, inventory, etc, hrs per week) ___ ___ ___

   Other (Please describe_____, hrs per week) ___ ___ ___

6. **Thesis** work that directly benefited the NEMESIS project.

Quarter	03-4	___	___
Hours (per week)	5-6	___	___

7. From the hours provided in question 6 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, and manual labor)?

Quarter	03-4	___	___
Learning (that did **not** directly develop NEMESIS, hrs per week)	2-3	___	___
Technical Labor (Primarily network related work, hrs per week)	___	___	___
Manual Labor (hrs per week)	___	___	___
Administrative Labor (Acquisition, inventory, etc, hrs per week)	2-3	___	___
Other (Please describe_____, hrs per week)	___	___	___

8. **Additional** work related to NEMESIS not captured above.

Quarter	___	___	___
Learning (that did **not** directly develop NEMESIS, hrs per week)	___	___	___
Technical Labor (Primarily network related work, hrs per week)	___	___	___
Manual Labor (hrs per week)	___	___	___
Administrative Labor (Acquisition, inventory, etc, hrs per week)	___	___	___
Other (Please describe_____, hrs per week)	___	___	___

9. Additional comments or information. I spent two days at Camp Roberts for shakedown mission during quarter 03-4.

NEMESIS PROJECT WORK SURVEY

1. **Course(s)** taken in direct support of NEMESIS. Course # IS 4925

   Quarter 1

   Lecture hrs 3

   Lab hrs indef.

2. Hours outside of class lecture that directly supported NEMESIS.

   Quarter 1

   Hours (per week) 6

3. From the hours provided in question 2 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, manual labor, and administrative)?

   Quarter 1

   Learning (that did **not** directly develop NEMESIS, hrs per week) 3

   Technical Labor (Primarily network related work, hrs per week) 2

   Manual Labor (hrs per week) 1

   Administrative Labor (Acquisition, inventory, etc, hrs per week) 0

   Other (Please describe_____, hrs per week) n/a

4. **Directed studies** taken in direct support of NEMESIS that is/are **not** listed above.

   Quarter 1

   Hours 6

5. From the hours provided in question 4 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, and manual labor)?

   Quarter 1

   Learning (that did **not** directly develop NEMESIS, hrs per week) 3

   Technical Labor (Primarily network related work, hrs per week) 2

   Manual Labor (hrs per week) 1

   Administrative Labor (Acquisition, inventory, etc, hrs per week) 0

   Other (Please describe_____, hrs per week) 0

6. **Thesis** work that directly benefited the NEMESIS project.

Quarter ___ ___ ___

Hours (per week) ___ ___ ___

7. From the hours provided in question 6 provide **a break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, and manual labor)?

Quarter ___ ___ ___

Learning (that did **not** directly develop NEMESIS, hrs per week) ___ ___ ___

Technical Labor (Primarily network related work, hrs per week) ___ ___ ___

Manual Labor (hrs per week) ___ ___ ___

Administrative Labor (Acquisition, inventory, etc, hrs per week) ___ ___ ___

Other (Please describe_____, hrs per week) ___ ___ ___

8. **Additional** work related to NEMESIS not captured above.

Quarter ___ ___ ___

Learning (that did **not** directly develop NEMESIS, hrs per week) ___ ___ ___

Technical Labor (Primarily network related work, hrs per week) ___ ___ ___

Manual Labor (hrs per week) ___ ___ ___

Administrative Labor (Acquisition, inventory, etc, hrs per week) ___ ___ ___

Other (Please describe_____, hrs per week) ___ ___ ___

9. Additional comments or information._____

_____

_____

_____

_____

VAN BRUNT

NEMESIS PROJECT WORK SURVEY

(*NOTE: using 12 wks/QTR)

1. **Course(s)** taken in direct support of NEMESIS. Course # IS-4925

IS 4925 Quarter Summer 2003

Lecture hrs 2

Lab hrs

2. Hours outside of class lecture that directly supported NEMESIS.

Quarter 84

Hours (per week) 7

43
43
86

3. From the hours provided in question 2 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, manual labor, and administrative)?

Quarter 84

Learning (that did **not** directly develop NEMESIS, hrs per week) 1 1/2

Technical Labor (Primarily network related work, hrs per week) 1/2

Manual Labor (hrs per week) 2

Administrative Labor (Acquisition, inventory, etc, hrs per week) 1

Other (Please describe DRIVING RV, etc, hrs per week) 2

2 TAD TRIPS (SANTA CRUZ & CAMP ROBERTS) 48 HRS each?

4. **Directed studies** taken in direct support of NEMESIS that is/are **not** listed above.

Quarter Spring 2003

[redacted] IS-4800

Hours 2

5. From the hours provided in question 4 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, and manual labor)?

Quarter 84

Learning (that did **not** directly develop NEMESIS, hrs per week) 1/2

Technical Labor (Primarily network related work, hrs per week) 1/2

Manual Labor (hrs per week) 3

Administrative Labor (Acquisition, inventory, etc, hrs per week) 1

Other (Please describe DRIVING, etc, hrs per week) 2

ASC - After Storage was established primarily as manual labor due to set up and a smaller amount going to technical set up. This was done for all other categories.

6. **Thesis** work that directly benefited the NEMESIS project.

Quarter	___	18	___
Hours (per week)	___	4	___

7. From the hours provided in question 6 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, and manual labor)?

Quarter	___	18	___
Learning (that did **not** directly develop NEMESIS, hrs per week)	___	1	___
Technical Labor (Primarily network related work, hrs per week)	___	1/2	___
Manual Labor (hrs per week)	___	1	___
Administrative Labor (Acquisition, inventory, etc, hrs per week)	___	1/2	___
Other (Please describe DRAWING, etc, hrs per week)	___	1	___

8. **Additional** work related to NEMESIS not captured above.

Quarter	___	___	___
Learning (that did **not** directly develop NEMESIS, hrs per week)	___	___	___
Technical Labor (Primarily network related work, hrs per week)	___	___	___
Manual Labor (hrs per week)	___	___	___
Administrative Labor (Acquisition, inventory, etc, hrs per week)	___	___	___
Other (Please describe_____, hrs per week)	___	___	___

9. Additional comments or information._____

Obviously these are estimates. Some weeks I devoted more time than others depending on other class/ family/etc commitments. These are best guess averaged estimates

NEMESIS PROJECT WORK SURVEY

1. **Course(s)** taken in direct support of NEMESIS.

	Course #			
	Quarter	03-3	03-4	___
	Lecture hrs	0	2	___
	Lab hrs	4	2	___

2. Hours outside of class lecture that directly supported NEMESIS.

Quarter	03-3	03-4	___
Hours (per week)	4	9	___

3. From the hours provided in question 2 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, manual labor, and administrative)?

	Quarter	03-3	03-4	___
Learning (that did **not** directly develop NEMESIS, hrs per week)		.5	1	___
Technical Labor (Primarily network related work, hrs per week)		1	4	___
Manual Labor (hrs per week)		2	2	___
Administrative Labor (Acquisition, inventory, etc, hrs per week)		.5	2	___
Other (Please describe_____, hrs per week)		___	___	___

4. **Directed studies** taken in direct support of NEMESIS that is/~~not~~ Are listed above.

Quarter	03-3	03-4	___
Hours	ø	ø	___

5. From the hours provided in question 4 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, and manual labor)?

	Quarter	03-3	03-4	___
Learning (that did **not** directly develop NEMESIS, hrs per week)		ø	ø	___
Technical Labor (Primarily network related work, hrs per week)		ø	ø	___
Manual Labor (hrs per week)		ø	ø	___
Administrative Labor (Acquisition, inventory, etc, hrs per week)		ø	ø	___
Other (Please describe_____, hrs per week)		ø	ø	___

6. **Thesis** work that directly benefited the NEMESIS project.

	Quarter	03-3	03-4	___
	Hours (per week)	Ø	Ø	___

7. From the hours provided in question 6 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, and manual labor)?

	Quarter	03-3	03-4	___
Learning (that did **not** directly develop NEMESIS, hrs per week)		Ø	Ø	___
Technical Labor (Primarily network related work, hrs per week)		Ø	Ø	___
Manual Labor (hrs per week)		Ø	Ø	___
Administrative Labor (Acquisition, inventory, etc, hrs per week)		Ø	Ø	___
Other (Please describe_____, hrs per week)		Ø	Ø	___

8. **Additional** work related to NEMESIS not captured above.

	Quarter	03-3	03-4	___
Learning (that did **not** directly develop NEMESIS, hrs per week)		Ø	Ø	___
Technical Labor (Primarily network related work, hrs per week)		Ø	Ø	___
Manual Labor (hrs per week)		Ø	Ø	___
Administrative Labor (Acquisition, inventory, etc, hrs per week)		Ø	Ø	___
Other (Please describe_____, hrs per week)		Ø	Ø	___

9. Additional comments or information. N/A

R. Munoz

NEMESIS PROJECT WORK SURVEY

1. **Course(s)** taken in direct support of NEMESIS. Course # IS 4925

   Quarter Summer 2003

   Lecture hrs 2hrs

   Lab hrs ~2 hrs

2. Hours outside of class lecture that directly supported NEMESIS.

   Quarter Summer03

   Hours (per week) 3

3. From the hours provided in question 2 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, manual labor, and administrative)?

   Quarter Sum03

   Learning (that did **not** directly develop NEMESIS, hrs per week) 2

   Technical Labor (Primarily network related work, hrs per week)

   Manual Labor (hrs per week)

   Administrative Labor (Acquisition, inventory, etc, hrs per week) 1

   Other (Please describe_____, hrs per week)

4. **Directed studies** taken in direct support of NEMESIS that is/~~are~~ **not** listed above.

   Quarter

   Hours N/A

5. From the hours provided in question 4 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, and manual labor)?

   Quarter

   Learning (that did **not** directly develop NEMESIS, hrs per week)

   Technical Labor (Primarily network related work, hrs per week)

   Manual Labor (hrs per week)

   Administrative Labor (Acquisition, inventory, etc, hrs per week)

   Other (Please describe_____, hrs per week)

(2) Working on course next quarter

6. **Thesis** work that directly benefited the NEMESIS project.

Quarter ___ ___ ___

Hours (per week) N/A ___ ___

7. From the hours provided in question 6 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, and manual labor)?

Quarter ___ ___ ___

Learning (that did **not** directly develop NEMESIS, hrs per week) ___ ___ ___

Technical Labor (Primarily network related work, hrs per week) ___ ___ ___

Manual Labor (hrs per week) ___ ___ ___

Administrative Labor (Acquisition, inventory, etc, hrs per week) ___ ___ ___

Other (Please describe_____, hrs per week) ___ ___ ___

8. **Additional** work related to NEMESIS not captured above. N/A.

Quarter ___ ___ ___

Learning (that did **not** directly develop NEMESIS, hrs per week) ___ ___ ___

Technical Labor (Primarily network related work, hrs per week) ___ ___ ___

Manual Labor (hrs per week) ___ ___ ___

Administrative Labor (Acquisition, inventory, etc, hrs per week) ___ ___ ___

Other (Please describe_____, hrs per week) ___ ___ ___

9. Additional comments or information. (1) Follow on class next quarter.
(2) Consumables cost - fuel, hydrogen fuel cells, etc.
(3) Administrative assistance - several Secretaries are currently used. A replication should have a person to keep inventory. Might not be a problem at an already established command.

John Weber

NEMESIS PROJECT WORK SURVEY

1. **Course(s)** taken in direct support of NEMESIS. Course # ___ ___ ___

   Quarter ___ ___ ___

   Lecture hrs ___ ___ ___

   Lab hrs ___ ___ ___

2. Hours outside of class lecture that directly supported NEMESIS.

   Quarter ___ ___ ___

   Hours (per week) ___ ___ ___

3. From the hours provided in question 2 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, manual labor, and administrative)?

   Quarter ___ ___ ___

   Learning (that did **not** directly develop NEMESIS, hrs per week) ___ ___ ___

   Technical Labor (Primarily network related work, hrs per week) ___ ___ ___

   Manual Labor (hrs per week) ___ ___ ___

   Administrative Labor (Acquisition, inventory, etc, hrs per week) ___ ___ ___

   Other (Please describe_____, hrs per week) ___ ___ ___

4. **Directed studies** taken in direct support of NEMESIS that is/are **not** listed above.

   Quarter ___ ___ ___

   Hours ___ ___ ___

5. From the hours provided in question 4 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, and manual labor)?

   Quarter ___ ___ ___

   Learning (that did **not** directly develop NEMESIS, hrs per week) ___ ___ ___

   Technical Labor (Primarily network related work, hrs per week) ___ ___ ___

   Manual Labor (hrs per week) ___ ___ ___

   Administrative Labor (Acquisition, inventory, etc, hrs per week) ___ ___ ___

   Other (Please describe_____, hrs per week) ___ ___ ___

MBA Project.

6. ~~Thesis~~ work that directly benefited the NEMESIS project.

Quarter	Sum03	___	___
Hours (per week)	7.5	___	___

7. From the hours provided in question 6 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, and manual labor)?

Quarter	___	___	___
Learning (that did **not** directly develop NEMESIS, hrs per week)	.5	___	___
Technical Labor (Primarily network related work, hrs per week)	___	___	___
Manual Labor (hrs per week)	.5	___	___
Administrative Labor (Acquisition, inventory, etc, hrs per week)	6	___	___
Other (Please describe Travel, hrs per week)	.5	___	___

mtg: mostly accounting some inv / admin

8. **Additional** work related to NEMESIS not captured above.

Quarter	___	___	___
Learning (that did **not** directly develop NEMESIS, hrs per week)	___	___	___
Technical Labor (Primarily network related work, hrs per week)	___	___	___
Manual Labor (hrs per week)	___	___	___
Administrative Labor (Acquisition, inventory, etc, hrs per week)	___	___	___
Other (Please describe_____, hrs per week)	___	___	___

9. Additional comments or information._____

Jeff Hock
TE FF,

NEMESIS PROJECT WORK SURVEY

1. **Course(s)** taken in direct support of NEMESIS. Course # ___ ___ ___

   Quarter ___ ___ ___

   Lecture hrs ___ ___ ___

   Lab hrs ___ ___ ___

2. Hours outside of class lecture that directly supported NEMESIS.

   Quarter ___ ___ ___

   Hours (per week) ___ ___ ___

3. From the hours provided in question 2 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, manual labor, and administrative)?

   Quarter ___ ___ ___

   Learning (that did **not** directly develop NEMESIS, hrs per week) ___ ___ ___

   Technical Labor (Primarily network related work, hrs per week) ___ ___ ___

   Manual Labor (hrs per week) ___ ___ ___

   Administrative Labor (Acquisition, inventory, etc, hrs per week) ___ ___ ___

   Other (Please describe_____, hrs per week) ___ ___ ___

4. **Directed studies** taken in direct support of NEMESIS that is/are **not** listed above.

   Quarter ___ ___ ___

   Hours ___ ___ ___

5. From the hours provided in question 4 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, and manual labor)?

   Quarter ___ ___ ___

   Learning (that did **not** directly develop NEMESIS, hrs per week) ___ ___ ___

   Technical Labor (Primarily network related work, hrs per week) ___ ___ ___

   Manual Labor (hrs per week) ___ ___ ___

   Administrative Labor (Acquisition, inventory, etc, hrs per week) ___ ___ ___

   Other (Please describe_____, hrs per week) ___ ___ ___

6. **Thesis** work that directly benefited the NEMESIS project. Sum03

Quarter None to date 2003-4 ___ ___

Hours (per week) 15 × 7 weeks ___ ___ ASC #5 averaged over 12 weeks vice 7 to match format of other surveys

7. From the hours provided in question 6 provide a **break down into type**, i.e. what portion was directly related to the following three categories (learning, technical labor, and manual labor)?

Quarter	×7			
Learning (that did **not** directly develop NEMESIS, hrs per week)	3	___	___	1.5
Technical Labor (Primarily network related work, hrs per week)	2	___	___	1.5
Manual Labor (hrs per week)	–	___	___	
Administrative Labor (Acquisition, inventory, etc, hrs per week)	1	___	___	4.5
Other (Please describe_____, hrs per week)	–	___	___	

8. **Additional** work related to NEMESIS not captured above.

Quarter	___	___	___	
Learning (that did **not** directly develop NEMESIS, hrs per week)	___	___	___	
Technical Labor (Primarily network related work, hrs per week)	___	___	___	
Manual Labor (hrs per week)	___	___	___	.5
Administrative Labor (Acquisition, inventory, etc, hrs per week)	___	___	___	
Other (Please describe Travel_____, hrs per week)	Weekends ×5/20	___	___	1.0

ASC adjustment to travel time for set up

9. Additional comments or information._____

NEMESIS PROGRAM MANAGER/PROJECT OFFICER SURVEY

Professor Brian Steckler

1. Average number of hours per week devoted to the NEMESIS, weekly estimates broken down by quarter.

Quarter	Wn 02	Sp 02	Sm 02	Fall 02	Wn 03	Sp 03	Sm 03
Hours (per week)	27	14	14	14	16	26	36

2. From the hours provided in question 1 please provide a **break down into type**, i.e. what portion was directly related to the following categories?

Quarter / (hrs/week)	Wn 02	Sp 02	Sm 02	Fall 02	Wn 03	Sp 03	Sm 03
Research	11	6	6	6			
Acquisition	10	5	5	5	5	5	8
Administration					10	10	5
Formal Instruction						5	10
Informal Instruction	3		2	2		5	5
Field testing							5
other (Presentations)	3	3	1	1	1	1	3

3. Additional comments or information. Large # hrs in Winter '02 due to many hrs of initial project research, sales pitches, make-vs-buy analysis, working w/ Kawaoka on initial thesis, working on the Nemesis CONOPS & Web site, etc. Slowed down next several quarters, then once we got the vehicle (Feb?) pace and demand on my time picked up significantly.... and remains high through Sept/Oct 2003.

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APPENDIX C-LABOR COST BASIS

The job descriptions used to estimate the labor costs from the BLS web site http://www.bls.gov/oes/2001/oes_nat.htm (10 Oct 2003).

Computer Support Specialists	493,240	$18.54	$20.16	$41,920	0.7 %

15-1041 Computer Support Specialists
Provide technical assistance to computer system users. Answer questions or resolve computer problems for clients in person, via telephone or from remote location. May provide assistance concerning the use of computer hardware and software, including printing, installation, word processing, electronic mail, and operating systems. Exclude "Network and Computer Systems Administrators" (15-1071).

Network and Computer Systems Administrators	227,840	$25.85	$27.14	$56,440	0.5 %

15-1071 Network and Computer Systems Administrators
Install, configure, and support an organization's local area network (LAN), wide area network (WAN), and Internet system or a segment of a network system. Maintain network hardware and software. Monitor network to ensure network availability to all system users and perform necessary maintenance to support network availability. May supervise other network support and client server specialists and plan, coordinate, and implement network security measures. Exclude "Computer Support Specialists" (15-1041).

Network Systems and Data Communications Analysts	126,060	$27.63	$28.99	$60,300	0.8 %

15-1081 Network Systems and Data Communications Analysts
Analyze, design, test, and evaluate network systems, such as local area networks (LAN), wide area networks (WAN), Internet, intranet, and other data communications systems. Perform network modeling, analysis, and planning. Research and recommend network and data communications hardware and software. Include telecommunications specialists who deal with the interfacing of computer and communications equipment. May supervise computer programmers.

Engineering Managers	214,760	$42.06	$42.74	$88,900	0.4 %

11-9041 Engineering Managers
Plan, direct, or coordinate activities in such fields as architecture and engineering or research and development in these fields. Exclude "Natural Sciences Managers" (11-9121).

Computer and Information Systems Managers	267,310	$39.65	$40.33	$83,890	0.4 %

11-3021 Computer and Information Systems Managers
Plan, direct, or coordinate activities in such fields as electronic data processing, information systems, systems analysis, and computer programming. Exclude "Computer Specialists" (15-1011 through 15-1099).

Accountants and Auditors	881,390	$21.82	$24.37	$50,690	0.4 %

13-2011 Accountants and Auditors
Examine, analyze, and interpret accounting records for the purpose of giving advice or preparing statements. Install or advise on systems of recording costs or other financial and budgetary data.

Budget Analysts	60,620	$24.29	$25.50	$53,040	0.5 %

13-2031 Budget Analysts
Examine budget estimates for completeness, accuracy, and conformance with procedures and regulations. Analyze budgeting and accounting reports for the purpose of maintaining expenditure controls.

Wholesale and Retail Buyers, Except Farm Products	131,670	$18.55	$21.25	$44,200	0.8 %

13-1022 Wholesale and Retail Buyers, Except Farm Products
Buy merchandise or commodities, other than farm products, for resale to consumers at the wholesale or retail level, including both durable and nondurable goods. Analyze past buying trends, sales records, price, and quality of merchandise to determine value and yield. Select, order, and authorize payment for merchandise according to contractual agreements. May conduct meetings with sales personnel and introduce new products. Include assistant buyers.

Electronic Equipment Installers and Repairers, Motor Vehicles	13,210	$12.14	$12.85	$26,740	1.7 %

49-2093 Electrical and Electronics Installers and Repairers, Transportation Equipment
Install, adjust, or maintain mobile electronics communication equipment, including sound, sonar, security, navigation, and surveillance systems on trains, watercraft, or other mobile equipment. Exclude "Avionics Technicians" (49-2091) and "Electronic Equipment Installers and Repairers, Motor Vehicles" (49-2096).

Recreational Vehicle Service Technicians	11,830	$12.70	$13.36	$27,780	0.9 %

49-3092 Recreational Vehicle Service Technicians
Diagnose, inspect, adjust, repair, or overhaul recreational vehicles including travel trailers. May specialize in maintaining gas, electrical, hydraulic, plumbing, or chassis/towing systems as well as repairing generators, appliances, and interior components. Include workers who perform customized van conversions. Exclude "Automotive Service Technicians and Mechanics" (49-3023) and "Bus and Truck Mechanics and Diesel Engine Specialists" (49-3031) who also work on recreation vehicles.

Maintenance and Repair Workers, General	1,232,280	$13.82	$14.54	$30,230	0.3 %

49-9042 Maintenance and Repair Workers, General
Perform work involving the skills of two or more maintenance or craft occupations to keep machines, mechanical equipment, or the structure of an establishment in repair. Duties may involve pipe fitting; boiler making; insulating; welding; machining; carpentry; repairing electrical or mechanical equipment; installing, aligning, and balancing new equipment; and repairing buildings, floors, or stairs. Exclude "Maintenance Workers, Machinery" (49-9043).

Helpers--Installation, Maintenance, and Repair Workers	148,390	$10.20	$11.16	$23,220	0.5 %

49-9098 Helpers--Installation, Maintenance, and Repair Workers
Help installation, maintenance, and repair workers in maintenance, parts replacement, and repair of vehicles, industrial machinery, and electrical and electronic equipment. Perform duties, such as furnishing tools, materials, and supplies to other workers; cleaning work area, machines, and tools; and holding materials or tools for other workers.

43-0000	Office and Administrative Support Occupations	22,798,590	$12.04	$13.09	$27,230	0.1 %

Bookkeeping, Accounting, and Auditing Clerks	1,697,890	$12.76	$13.38	$27,820	0.2 %

43-3031 Bookkeeping, Accounting, and Auditing Clerks
Compute, classify, and record numerical data to keep financial records complete. Perform any combination of routine calculating, posting, and verifying duties to obtain primary financial data for use in maintaining accounting records. May also check the accuracy of figures, calculations, and postings pertaining to business transactions recorded by other workers.

Weighers, Measurers, Checkers, and Samplers, Recordkeeping	78,620	$11.87	$13.10	$27,240	1.3 %

43-5111 Weighers, Measurers, Checkers, and Samplers, Recordkeeping
Weigh, measure, and check materials, supplies, and equipment for the purpose of keeping relevant records. Duties are primarily clerical by nature. Include workers who collect and keep record of samples of products or materials. Exclude production "Inspectors, Testers, Sorters, Samplers, and Weighers" (51-9061).

Data Entry Keyers	405,000	$10.56	$10.93	$22,740	0.4 %

43-9021 Data Entry Keyers
Operate data entry device, such as keyboard or photo composing perforator. Duties may include verifying data and preparing materials for printing. Exclude "Word Processors and Typists" (43-9022).

Procurement Clerks	74,740	$13.84	$14.17	$29,480	0.3 %

43-3061 Procurement Clerks
Compile information and records to draw up purchase orders for procurement of materials and services.

Computer Science Teachers, Postsecondary	29,690	(4)	(4)	$53,790	1.0 %

25-1021 Computer Science Teachers, Postsecondary
Teach courses in computer science. May specialize in a field of computer science, such as the design and function of computers or operations and research analysis. Include both teachers primarily engaged in teaching and those who do a combination of both teaching and research.

APPENDIX D-VEHICLE COST BENEFIT ANALYSIS

NEMESIS PROJECT COST-BENEFIT ANALYSIS

Prepared By:
Mr. Paul R. Schoberg
Naval Postgraduate School
29-Oct-2002

PURPOSE

This cost-benefit analysis is intended to help determine the best option to serve as the Cebrowski Institute Nemesis Project vehicle platform.

METHOD

Determine or estimate costs and other factors for each type of vehicle under consideration. Place costs and other factors on a spreadsheet and reduce each factor to a number that expresses the relative desirability of that factor, then sum these numbers to determine an overall rating. If all the factor numbers are relatively important ("relatively important" means that 1.0 expresses baseline desirability of each factor and that each factor is of the same magnitude,) then the total computed cost factor represents the overall desirability of that vehicle. The vehicle with the lowest factor is the most desirable vehicle, all things considered.

VEHICLES UNDER CONSIDERATION

Several vehicle options are compared:
New RV
Used RV
LDV Van
Ford Van
GM Van

For each vehicle, several factors are considered:
Acquisition
Configuration
Maintenance
Time To Delivery
Crew Comforts
Insurance

The calculation spreadsheets are designed to easily add more factors, if desired.

DESCRIPTION OF VEHICLE OPTIONS

RECREATIONAL VEHICLE

New or Used: The vehicle may be purchased new or used. Both options are compared.

General: The suitable recreational vehicle is a Class-A vehicle of length between 30 and 35 feet. It has the usual compliment of sleeping quarters, galley, head, air conditioning and power supply. A configuration must be selected so that there is an area suitable for retrofit such that the Nemesis computer equipment and operator work stations can be installed.

Retrofit: We expect to remove a "back bedroom" from the RV and use that area for installation of the Nemesis computer equipment and operator workstations. The area may also be used as a re-configurable NOC.

Antenna Patch Panel: We expect to install an antenna patch panel in the roof of the vehicle, so that there is an electrical interface between the computer network inside the vehicle and the antenna array external to the vehicle.

Air Conditioning: We expect the A/C system to be generally suitable; however, we allow for retrofit of the system in the event that additional cooling is required in support of the installed equipment suite.

Electrical Power: We expect the "stock" RV electrical system to be inadequate and therefore allow for retrofit and upgrade of the system.

Time-To-Delivery: The time to delivery refers to the amount of time required to acquire and configure the vehicle. It depends upon how quickly NPS personnel can retrofit the vehicle. An estimate of this is from one to four months, and represented in the calculation as baseline (factor = 1.0), and could be as short as a few weeks if retrofitting proceeds smoothly.

LDV VAN

LDV Corporation of Burlington, WI, is a builder of custom command vehicles. Their speciality is building exactly the type of vehicle suitable for Nemesis. LDV would build the most complete vehicle of all the options under consideration.

An LDV van would come equipped with an adequate work area, computer network, antenna patch panel, air conditioning and power, and would require no retrofit. NPS would only have to place the equipment and hook it to the installed computer network.

According to LDV, we could elect to not have installed several of their standard options that are not required for Nemesis, thus bringing down the cost of acquisition. For the purpose of this study, we estimate the impact of this rather than strictly quantify it. If the

cost-benefit analysis shows that the LDV option is the best, then we would further engage LDV to design the vehicle with the appropriate options. If the cost-benefit analysis shows the LDV option is not preferred, then we have saved the work of this design for both ourselves and for LDV.

LDV has a time-to-delivery of between six and nine months, once the design is complete and the order to manufacture is given.

DESCRIPTION OF VEHICLE OPTIONS, Continued

FORD and GM VAN

Similar to LDV, the major vehicle manufacturers have industrial truck divisions that can produce command vehicles. We selected local Ford and GM dealers to provide quotes; however, neither company has yet responded to this request. Therefore, we estimate the acquisition cost of their products and include that in this analysis.
Through discussion with each vendor despite the lack of price quotes, both Ford and GM would not provide as complete a vehicle as LDV. They would not be able to install computer equipment (such as backbone cabling), workstation counter areas, antenna patch panel, or unusual requests for air conditioning and power systems. It should be noted that there may be a sub-contractor that Ford and GM may work with that could provide these items, but we do not know the extent of their capability because the vendors have not yet responded with quotes.
The time-to-delivery, once the design is complete and the order is given, is estimated to be near the LDV time-to-delivery although not quite as long, and longer than retrofitting an RV.

SPREADSHEETS

These are two spreadsheets used for calculation. They are entitled "Nemesis Vehicle Acquisition and Configuration Cost" and "Nemesis Platform Cost-Benefit Analysis".

The former estimates the acquisition and configuration cost for each platform under consideration.

The latter uses the result of the former combined with other factors and calculates the total cost-benefit factor in an effort to determine the most suitable vehicle platform.

NEMESIS VEHICLE ACQUISITION AND CONFIGURATION COST SPREADSHEET

This spreadsheet estimates the acquisition and configuration cost for each platform under consideration.

Cells shaded in GREEN indicate acquisition and no further action required on the part of NPS to configure the vehicle.

Cells shaded in RED indicate items that require action on the part of NPS to configure the vehicle.

All cost figures are estimated. Additional factors can be easily added to the spreadsheet and the presented factors and costs can be easily modified if the provided estimates should be altered.

BOTTOM LINE: The "Used RV" option is the least expensive vehicle to acquire and configure.

NEMESIS PLATFORM COST-BENEFIT ANALYSIS
This spreadsheet uses the result of the Nemesis Vehicle Acquisition and Configuration Cost spreadsheet combined with other factors and calculates the total cost-benefit factor in an effort to determine the most suitable vehicle platform.

In consideration of the acquisition and configuration cost, the value for each vehicle option is transferred from the Nemesis Vehicle Acquisition and Configuration Cost spreadsheet and compared with a baseline cost. $100,000 was chosen as the baseline. A cost above the baseline makes the vehicle less desirable and a cost below the baseline makes the vehicle more desirable. A ratio is calculated between the acquisition and configuration cost and the baseline, then multiplied by a weighting factor to bring its relative importance in line with the other factors.

In consideration of other factors, which include maintenance, time to delivery, crew comforts and insurance, the relative importance of each is entered into the spreadsheet.

Cost of fuel was purposely omitted because it is thought to be relatively the same for each vehicle, and therefore including it would not affect the overall outcome of the cost-benefit analysis.

Because all the benefit factors are relatively of the same magnitude and are weighted appropriately, they can be simply summed to arrive at the overall cost-benefit "total score". The lowest total score is the most desirable vehicle option.

CONCLUSION
The "Used RV" option has the lowest total cost-benefit score and is the most desirable option.

Assuming the estimates are valid and reasonable, computing the score as described using the estimates given is a good way to estimate the best vehicle option. My feeling coincides with the computation. The biggest trade-off is that for lower acquisition cost there is more work required for NPS to outfit the vehicle.

Additionally, the "Used RV" option is the quickest to implement. LDV, for example, takes 6-9 months or more to build a van once the order is given. Acquiring a new or used RV reduces the time required to achieve a fully functional van to only a month or two, or perhaps as short as a few weeks if configuration proceeds smoothly.

ATTACHMENTS

Nemesis Vehicle Acquisition and Configuration Cost (spreadsheet)

Nemesis Platform Cost-Benefit Analysis (spreadsheet)

Attachment 1
NEMESIS VEHICLE
ACQUISITION AND CONFIGURATION COST

Prepared By: P. Schoberg | 29 OCT 02

	VEHICLE OPTION				
REQUIREMENT	New RV	Used RV	LDV	Ford	GM
Purchase Vehicle	75,000	45,000	175,000	80,000	80,000
Remove Bedroom	2,500	2,500	-	-	-
Install Adequate A/C System	4,000	4,000	-	4,000	4,000
Install Adequate Electrical Power	5,000	5,000	-	4,000	4,000
Install Antenna Patch Panel	2,000	2,000	-	2,000	2,000
Install Equipment Racks	500	500	-	500	500
Install Network Backbone Cabling	500	500	-	500	500
Install Work Station Areas	2,500	2,500	-	2,500	2,500
Miscellaneous Accessories	2,500	2,500	2,500	2,500	2,500
TOTAL Acquisition & Configuration	94,500	64,500	177,500	96,000	96,000

Attachment 2
NEMESIS PLATFORM COST-BENEFIT ANALYSIS

Prepared By: P. Schoberg | 29 OCT 02

	VEHICLE OPTION				
ITEM / BENEFIT	New RV	Used RV	LDV	Ford	GM
Acquisition & Configuration	$94,500	$64,500	$177,500	$96,000	$96,000
Baseline Purchase & Configuration	100,000	100,000	100,000	100,000	100,000
Difference: (Line 5) - (Line 6)	(5,500)	(35,500)	77,500	(4,000)	(4,000)
Cost Factor: (Line 5) / (Line 6)	0.95	0.65	1.78	0.96	0.96
Cost Factor Multiplier (Importance)	2.0	2.0	2.0	2.0	2.0
Acquisition (Lower = Better)	1.89	1.29	3.55	1.92	1.92
Maintenance (New vehicle = 1.0)	1.0	1.3	1.0	1.0	1.0
Time To Delivery (1.0+0.2/month)	1.2	1.2	2.6	1.8	1.8
Time To Configure (1.0+0.2/month)	1.6	1.8	1.0	1.6	1.6
Crew Comforts (Lower = Better)	1.0	1.0	1.2	1.5	1.5
Insurance (Lower = Cheaper)	1.1	1.0	1.5	1.2	1.2
Total Score (Lowest = best C/B)	7.79	7.59	10.85	9.02	9.02

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APPENDIX E-MAINTENANCE AND REPAIR DATA

Appendix F includes specifics as to the breakout of the repair and maintenance line items as well as general maintenance schedules for the MNOC and Onan generators.

Risco, Inc.

25 West Highland Avenue
Atlantic Highlands, NJ 07716 * (732) 872-7722

The Following is a Recommended Maintenance Schedule to Insure The Safety, Dependability and Enjoyable Use of Your Coach.

1. Engine Oil & Oil Filter Change: Always use SF/CC or SF/CD quality energy conserving oils of the proper viscosity. Also, always change the oil and filter as soon as possible after driving in a dust storm. SCHEDULE: EVERY 3,000 / 6,000 / 9,000/ 12,000 / 15,000 / 18,000 / 21,000 / 24,000 & EVERY 30,000 MILES.

2. Chassis Lubrication
   SCHEDULE: EVERY 4 MONTHS or 6,000 / 12,000 / 18,000 / 24,000 & EVERY 60,000 MILES.

3. Cooling System Service: Drain, flush and refill system with new coolant.
   SCHEDULE: EVERY 24 MONTHS OR 24,000 AND 48,000 MILES.

4. Air Cleaner Element Replacement: Replace at specific intervals; more often under dusty conditions.
   SCHEDULE: 24,000 OR 48,000 MILES.

5. Front Wheel Bearing Repack: Clean and repack the front wheel bearings at each brake relining, or at specified intervals, whichever comes first.
   SCHEDULE: 12,000 / 24,000 / 36,000 / 48,000 AND 60,000 MILES.

6. Transmission Service:

AUTOMATIC TRANSMISSIONS: Change the transmission fluid and filter every 15,000 miles for vehicles under 8600 GVWR, or every 12,000 miles for vehicles over 8600 GVWR if the vehicle is mainly driven under one or more of these conditions:

- In heavy city traffic where the outside temperature regularly reaches 90° or higher.
- In hilly or mountainous terrain.
- Frequent trailer-pulling.
- Uses such as taxi or delivery service.

If the vehicle is not used mainly under any of these conditions, change the fluid and filter every 30,000 miles for vehicles under 8600 GVWR, or every 24,000 miles for vehicles over 8600 GVWR.

7. PCV System Inspection: Check that the PCV system works properly. Replace the valve as necessary and any worn, plugged or collapsed hoses.

8. Fuel Filter Replacement: Replace the fuel filter at the specified intervals or sooner if clogged.

SCHEDULE: EVERY 12,000 / 24,000 / 36,000 / 48,000 AND 60,000 MILES.

9. Spark Plugs:

SCHEDULE: 12,000 / 24,000 / 36,000 / 48,000 AND 60,000 MILES.

10. Wire Service: Clean wires and inspect for burns, cracks or other damage. Check the wire boot fit at the distributor and the spark plugs. Replace wires as needed.

11. Fuel Tank, Cap & Lines Inspection: Inspect the fuel tank, cap and lines for damage or leaks. Remove fuel cap, inspect gasket for an even filler neck imprint and any damage. Replace parts as needed.

12. Engine Accessory Drive Belts Inspection: Inspect belts, look for cracks, fraying wear and improper tension. Adjust or replace as needed.

The NetWarVan is equipped with two 7kw Onan generators, therefore, below is the maintenance schedule for said generators.

Onan RV Genset Maintenance Intervals

Model / Item	Monthly	Hour Meter Reading 100	150	200	250	500
Microlite 2800						
Clean And Check Battery And Connection	X					
Clean Spark Arrester			X			
Change Oil/Oil Filter		X				
Change Air Filter				X		
Clean Spark Plugs				X		
Change Fuel Filter						X
Schedule Onan Service Center Tune-Up						X
Microlite 4000						
Clean And Check Battery And Connection	X					
Clean Spark Arrester			X			
Change Oil/Oil Filter			X			
Change Air Filter					X	
Clean Spark Plugs						X
Change Fuel Filter						X
Schedule Onan Service Center Tune-Up						X
Emerald						
Clean And Check Battery And Connections	X					
Clean Spark Arrester			X			
Change Oil/Oil Filter			X			
Change Air Filter			X			
Clean Spark Plugs			X			
Change Fuel Filter			X			
Schedule Onan Service Center Tune-Up			X			
Emerald Plus and Marquis						
Clean And Check Battery And Connections	X					
Clean Spark Arrester			X			
Change Oil/Oil Filter			X			
Change Air Filter				X		
Change Spark Plugs						X
Change Fuel Filter						X
Schedule Onan Service Center Tune-Up						X
Diesel						
Clean And Check Battery And Connection	X					
Clean Spark Arrester			X			
Change Oil/Oil Filter (Except Quiet Diesel)		X				
Change Oil/Oil Filter (Quiet Diesel 7500/8000)			X			
Change Oil/Oil Filter (Quiet Diesel 10,000/12,500)					X	
Change Air Filter						X
Change Fuel Filter					X	
Schedule Onan Service Center Checkup						X

www.StandbyPower.com
Cummins Michigan Power Inc.

The following spreadsheet is provided by RVersOnline.com. It highlights the differences in cost between new and used ownership. This may be useful information when the time comes to replace the current NetWarVan and/or replicate the MNOC. Specifically of interest to this project in this appendix is the estimated annual service (maintenance) costs based on the use indicated. As we indicated in the project we started with the below estimated $400.00 for 10,000 miles or fewer of use per year and then added costs to this based on the number of users, lack of familiarity, etc.

EVALUATION OF OWNERSHIP COST OF NEW VS USED (3 years old) LUXURY RV

CONSTANTS:		DEPRECIATION SCHEDULE	
Fuel Cost	1.30	Year	
MPG	7	18.00%	1
Insurance Cost per year	1000	10.00%	2
Miles per Year	25000	7.00%	3
Service Cost per 10,000 miles	400	6.00%	4
License Cost per year	200	6.00%	5
Interest Rate	8.00%	5.00%	6
Use Days per year	140	5.00%	7
Camping Days per year	80	4.00%	8
Average Camping Cost	20	4.00%	9
New Set of Tires	1800	3.00%	10
Miles per set of Tires	60000	2.00%	11 Same for every year after
Purchase Price	100000		

YEARS OWNED	NEW RV FAIR MARKET PRICE	COST OF $ PLUS DEPRECIATION	OPERATING COST	CAMPING COST	YEARLY COST TO OWN	COST PER MILE	COST PER DAY OF USE	CUMM. COST TO OWN	RATIO NEW TO USED
	100000								
1	82000	26000	7593	1600	35193	1.41	251.38	35193	172.57%
2	72000	16560	7593	1600	25753	1.03	183.95	60946	151.21%
3	65000	12760	7593	1600	21953	0.88	156.81	82899	141.13%
4	59000	11200	7593	1600	20393	0.82	145.66	103291	134.54%
5	53000	10720	7593	1600	19913	0.80	142.23	123204	131.90%
6	48000	9240	7593	1600	18433	0.74	131.66	141637	129.09%
7	43000	8840	7593	1600	18033	0.72	128.81	159670	128.03%
8	39000	7440	7593	1600	16633	0.67	118.81	176303	127.33%
9	35000	7120	7593	1600	16313	0.65	116.52	192616	126.67%
10	32000	5800	7593	1600	14993	0.60	107.09	207609	125.45%

YEARS OWNED	USED RV 3 YEARS OLD								
	65000								
1	59000	11200	7593	1600	20393	0.82	145.66	20393	57.95%
2	53000	10720	7593	1600	19913	0.80	142.23	40306	66.13%
3	48000	9240	7593	1600	18433	0.74	131.66	58739	70.86%
4	43000	8840	7593	1600	18033	0.72	128.81	76771	74.33%
5	39000	7440	7593	1600	16633	0.67	118.81	93404	75.81%
6	35000	7120	7593	1600	16313	0.65	116.52	109717	77.46%
7	32000	5800	7593	1600	14993	0.60	107.09	124710	78.10%
8	30000	4560	7593	1600	13753	0.55	98.23	138463	78.54%
9	28000	4400	7593	1600	13593	0.54	97.09	152056	78.94%
10	26000	4240	7593	1600	13433	0.54	95.95	165489	79.71%

APPENDIX F-MISSION COSTING WORKSHEET

Appendix G contains the mission costing worksheet. The mission costing worksheet is used to estimate mission costs and finalize mission cost assessments. The mission costing worksheet is limited to one sheet of paper (printed both the front and back). To preserve the presentation of the mission costing worksheet it is presented on the following two pages.

Mission Costing Worksheet

Labor (chargeable time = total mission duration plus travel time)

-Program Manager ($50/hr) _____ x _____ Time (hrs) _____

-Outsourced Labor ($45/hr-65/hr) # Personnel _____ x _____ Time (hrs) _____

-Lab Tech (GS-13) ($30/hr) # Personnel _____ x _____ Time (hrs) _____

Total Labor Cost _____

Equivalent labor value for student participation (ELVSP)

-Non-billed ($25/hr) # Personnel _____ x _____ Time (hrs) _____

-Trip Report $100

-Thesis Report (30 x $50+25 x $600) x pro-rate= $16,500 x pro-rate _____

pro-rate TBD on a case-by-case basis

- Test and Evaluation report (cost depends on report requirements) _____

Total ELVSP Cost _____

Materials

- Fuel NetWarVan _____

- Hydrogen (bottled) _____

- Satellite Internet Usage (min) _____ x 0.75 ($ / min) _____

Total Materials Cost _____

Lodging, M & IE

- M & IE (meals and incidentals) # Pers ____#Days____ x ____Area Per Diem _____

- Lodging (with days for travel)* # Pers ____#Days____ x _____Area lodging _____

Total Lodging, M & IE Cost _____

Overhead (Includes costs associated with equipment, vehicle, and power generation.)

- (Starting Mileage _____ - Ending Mileage_____)x $1.57 _____

- POV Mileage_____ x $0.38 x # POV_____ _____

- Setup cost $290

- Duration of mission (in days, travel not included) _____ x $420 _____

- Duration NetWarVan used for lodging (in days) _____ x $20 _____

- Duration of Power Generation (shifts*, shift range 0 – 2 per day) _____ x $20 _____

Fuel for generator fuel costs _____x shifts_____x 8 = _____

* There are two shifts per day one during the daytime or mission execution and the other during the night (i.e. if the RV is being used for accommodations)

- Period cost (see attached table cost) _____

Total Overhead Cost _____

Summary of Mission Cost

Total Labor Cost _____

Total ELVSP Cost _____

Total Materials Cost _____

Total Lodging, M & IE Cost _____

Total Overhead Cost _____

_____

Total Mission Cost _____

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