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THESIS

SYSTEM ARCHITECTURE FOR THE ARMY SPECIAL OPERATIONS FORCES (ARSOF) SOLDIER SYSTEM

by

Donald D. Ottilige

June 1996

Principal Advisor: Orin E. Marvel

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This thesis is based on proposing a system architecture for the Army Special Operations Forces (ARSOF) soldier. This system architecture will be based on object orientation and include Quality of Life (QOL) and Base Operations (BASOPS) programs integrated into the system architecture. The primary focus for this thesis is to propose a method or architecture to portray the ARSOF soldier as a system so that it can adequately compete against other weapon systems. The second reason is to identify and prioritize those functions and material which have an effect on the soldier and his mission accomplishment. It is a concern that the ARSOF soldier is being left out of the acquisition process because it is not perceived as a weapon system. This leaves the soldier vulnerable to inadequate funding which ultimately results in an ill-equipped and degraded capability for accomplishing present and future missions. USASOC wants to include not only material systems as part of the ARSOF soldier but also other intangible issues such as quality of life systems and base operations systems which have an effect on the ARSOF soldier's combat effectiveness. Army Special Operations requires specially trained soldiers and unique equipment that is not utilized by conventional forces. This system architecture will take special requirements into account. If the Army Special Operations soldier can be portrayed as a system, USASOC wants to determine how much of that system it has control or influence over, and how much it does not.

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SYSTEM ARCHITECTURE FOR THE ARMY SPECIAL OPERATIONS FORCES (ARSOF) SOLDIER SYSTEM

Donald D. Ottilige
Captain, United States Army
B.S., The Citadel, 1985

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June 1996

Author: Donald D. Ottilige
Donald D. Ottilige

Approved by: Orin E. Marvel
Orin E. Marvel, Principal Advisor

Keith Snider, Associate Advisor

Reuben T. Harris
Reuben T. Harris, Chairman
Department of Systems Management

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This thesis is based on proposing a system architecture for the Army Special Operations Forces (ARSOF) soldier. This system architecture will be based on object orientation and include Quality of Life (QOL) and Base Operations (BASOPS) programs integrated into the system architecture. The primary focus for this thesis is to propose a method or architecture to portray the ARSOF soldier as a system so that it can adequately compete against other weapon systems. The second reason is to identify and prioritize those functions and material which have an effect on the soldier and his mission accomplishment. It is a concern that the ARSOF soldier is being left out of the acquisition process because it is not perceived as a weapon system. This leaves the soldier vulnerable to inadequate funding which ultimately results in an ill-equipped and degraded capability for accomplishing present and future missions. USASOC wants to include not only material systems as part of the ARSOF soldier but also other intangible issues such as quality of life systems and base operations systems which have an effect on the ARSOF soldier's combat effectiveness. Army Special Operations requires specially trained soldiers and unique equipment that is not utilized by conventional forces. This system architecture will take special requirements into account. If the Army Special Operations soldier can be portrayed as a system, USASOC wants to determine how much of that system it has control or influence over, and how much it does not.

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LIST OF ACRONYMS

AIT	Advanced Individual Training
ALO	Authorized Level of Organization
ANCOC	Advanced Non-Commissioned Officer Course
AR	Army Regulation
ARI	Army Research Institute
ARSOF	Army Special Operations Forces
ASD	Assistant Secretary of Defense
ATC	All Terrain Cycle
AWE	Advanced Warfighting Experiment
BASOPS	Base Operations
BDU	Battle Dress Uniform
CLW	Consolidate Land Warrior
CS	Chemical Smoke
C3	Command, Control, Communications
C-4	Composition 4 explosive
C4I	Command, Control, Communications, Computers, Intelligence
DEET	n-diethyl-m-toluamide
DFT	Deployment For Training
DS	Direct Support

DTLOMS	Doctrine, Training, Leadership Development, Organization, Materiel Soldier
EXSUM	Executive Summary
FM	Field Manual
GEN II	Generation II Soldier System
GPS	Global Positioning System
HALO	High Altitude Low Opening
HMMWV	High Mobility Multi-Purpose Wheeled Vehicle
IFF	Identification Friend or Foe
IHS	Integrated Headgear Subsystem
IPDT	Integrated Product Development Team
IPS	Interface and Power Subsystem
ISC/R	Individual Soldier Computer/Radio
IQ	Intelligence Quotient
JCS	Joint Chiefs of Staff
JRTC	Joint Readiness Training Center
LAWS	Light Anti-Tank Weapon System
LEAP	Lower Extremity Assistance for Parachutists
LW	Land Warrior
MAA	Mission Area Analysis
MANPRINT	Manpower and Personnel Integration

MILCON	Military Construction
MOA	Memorandum of Agreement
MOPP	Mission Oriented Protective Posture
MOS	Military Occupational Specialty
MTT	Mobile Training Team
MWR	Morale, Welfare, Recreation
NBC	Nuclear, Biological, Chemical
OPTEMPO	Operational Tempo
PCS	Permanent Change of Station
PERSTEMPO	Personnel Tempo
PLDC	Primary Leadership Development Course
PM	Program Manager
POL	Petroleum, Oils, Lubricants
POM	Program Objective Memorandum
PS	Protective Subsystem
PT	Physical Training
PX	Post Exchange
QOL	Quality of Life
RAAWS	Ranger Anti-Armor Weapon System
RPMA	Real Property Maintenance Activities
RPG	Rocket Propelled Grenade

SCUBA	Self Contained Underwater Breathing Appratus
SF	Special Forces
SIPE	Soldier Integrated Protective Ensemble
SLAM	Selective Lightweight Attack Munition
SMU	Special Mission Unit
SOF	Special Operations Forces
SOFCOST	Special Operations Forces Cost
SO/LIC	Special Operations/Low Intensity Conflict
SPIES	Special Patrol Infiltration Exfiltration System
TDY	Temporary Duty
TNT	Trinitrotoluene
TRADOC	Training and Doctrine Command
USACAPOC	U.S. Army Civil Affairs and Psychological Operations Command
USAJFKSWCS	U.S. Army John F. Kennedy Special Warfare Center and School
USASOC	U.S. Army Special Operations Command
USO	Uniformed Services Organization
WAM	Wide Area Mine
WIS	Weapon Interface Subsystem
21st CLW	21st Century Land Warrior

I. INTRODUCTION

A. OVERVIEW

In July 1991, then Chief of Staff of the U.S. Army, General Gordon Sullivan said:

> Our war fighting edge is the combined effect of quality people, trained to razor sharpness, outfitted with modern equipment, led by tough, competent leaders, structured into an appropriate mix of forces by type, and employed according to up-to-date doctrine.... I am certain the single most important factor is the soldier. [Ref. 10:p. 4]

The soldier is the United States Army Special Operations Command (USASOC)'s primary weapon system. Not only is the soldier the oldest system, but it is also the most adaptable. Many pieces of equipment and material have become obsolete, but the soldier has been able to adapt to each change in warfare and still play a dominant role in its execution. The 1950s heralded an age of supposed "push button warfare" which some said would eliminate the need for soldiers on the ground. Forty years later, the soldier is still playing the key role in special and conventional operations.

A major problem is that the Army Special Operation Forces (ARSOF) soldier has not been treated as a system until recently. Areas that affect the soldier have been developed in isolation. This haphazard approach has, in the long run, stunted a unified effort to train, equip, maintain, and sustain the soldier for the present and future battlefield. As a result, the soldier, his* equipment, and the environment in which he operates have been ignored as a combined system. Patrick Snow,

*Army Special Operations combat arms slots are still male. Female participation is still delegated to combat support and combat service support slots. Overall, female participation in Army Special Operations is very small.

GEN II Advanced Technology Demonstration (ATD) Manager, at the Army's Natick Research, Development and Engineering Center said, "The soldier is the most important system in the Army. It's the soldier who drives the tank, fires the weapons, and flies the helicopters. Yet for years, the Army concentrated on crafting advanced vehicles and weapons, while GIs weren't even issued soldier-to-soldier radios." [Ref. 13:p. 64]

The 21st Century Land Warrior program has made great strides to bring the concept of the "soldier as a system" to reality. The problem is that there are other items to consider within a soldier system than just materiel issues. The following diagrams depict the current situation of the soldier system as well as the goal for a possible future ARSOF Soldier System.

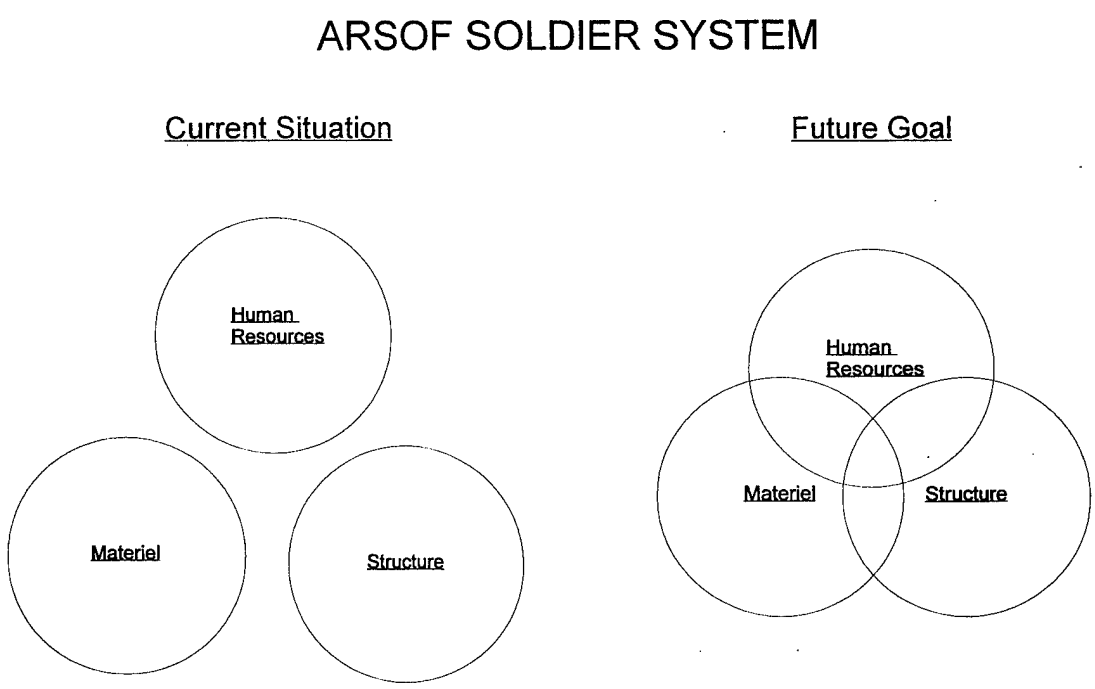

Figure 1-1. Current and Future ARSOF System

Technology in the United States has made great strides since World War II, yet the soldier has slowly fallen behind to advances made by this technology. For example, communications have become very lightweight and can transmit great distances due to satellite technology. The soldier is still encumbered by a heavy radio with an accompanying amount of heavy replacement batteries. Another example is that Kevlar and body armor protection is still heavy for the soldier, but yet there are new materials for body protection that could be utilized. Some say that technology will replace the soldier, but this idea is a long way from reality. The fact is that instead of replacing the soldier, technology will be there to enhance his skills and increase the probability of a successful mission. Support systems, organizations, and equipment have all been developed and fielded to the soldier in isolation from other systems. Only due to the soldier's inherent capabilities to improvise and adapt has he been able to overcome these integration problems. [Ref. 19:pp. 11-20]

B. PURPOSE

This research will explore the feasibility of portraying and supporting an ARSOF Soldier System. The catalyst for this study is a request by the USASOC Director of Combat Developments, Mr. Odie Knight, to find a method or architecture to portray an ARSOF Soldier System so that he can adequately compete for resources against other weapon systems. The second reason is to identify and prioritize those functions and materiel which have an effect on the soldier and his mission accomplishment. It is feared that the ARSOF soldier is being left out of the acquisition process because he is not perceived as a weapon system. This leaves the ARSOF soldier in danger of not being funded properly to have him equipped and capable of accomplishing present and future missions. USASOC wants to include not only materiel systems as part of the ARSOF soldier but also other intangible issues such as quality of life and base operations systems. USASOC also wants to know that

once the ARSOF soldier is portrayed as a system, how much of that system it has control or influence over and how much it does not. [Ref. 30]

C. OBJECTIVES

The primary research question is: How can the ARSOF soldier be portrayed as a system so that it can compete for resources against other weapon systems? The following subsidiary questions will also be explored:

1. How is the ARSOF soldier portrayed as a system at present?
2. What is USASOC's vision to portray the soldier as a system?
3. What is the proposed system for the ARSOF soldier?
4. How is USASOC's vision similar or different to the conventional 21st Century Land Warrior?
5. How is the proposed USASOC system similar or different to the conventional 21st Century Land Warrior?
6. What part of the ARSOF soldier system would USASOC have control or influence over?
7. What part of the ARSOF soldier system would USASOC not have control or influence over?

D. METHODOLOGY

An overview was conducted of the available literature on the ARSOF soldier, his equipment, and his organization. This set the stage for discussion and analysis of the current ARSOF Soldier System. From this examination, a possible new ARSOF Soldier System will be presented. This ARSOF Soldier System within this thesis is not intended to be the final product but is intended to be an approach for developing a soldier system for USASOC. The consequences and implications of that model will

then be elaborated. Finally, a recommendation will be given as to how this system architecture can be utilized by USASOC.

E. LITERATURE REVIEW

Previous research of the ARSOF Soldier System has only covered material aspects. The literature and background research centered on two areas: the current Soldier System concept and the aspect of quality of life of the soldier. Some background research also covered the Special Operations organization. This thesis will combine all three of these areas of research to discuss the concept of a Soldier System model. The literature review will be broken down into three segments. The first segment will review the literature of the present Soldier System efforts; the second will review the quality of life issues that affect the soldier; and the third segment will review the aspects of the Special Operations organization.

F. PRESENT SOLDIER SYSTEMS

In studying the problem of the ARSOF Soldier System, no past research was found that has fully studied the soldier as a system. Most of the studies that dealt with the soldier are divided into two categories: hardware and behavior. These studies have focused on how to equip the soldier properly or what the soldier's attitudes and behavior are under certain conditions. For example, the 21st Century Land Warrior program and the GEN II Soldier program have focused only on the material aspects of the system. The other side studied has been behavioral aspects of the soldier. These have been looked at separately in order to study the various aspects of the soldier and why he behaves as he does. There have been some studies as to how these various behavior patterns interact and affect each other. But there is no literature that links these two functions together to discuss or measure how each affects the other. Instead, the research has treated these two aspects as basically unrelated. For example, Manpower and Personnel Integration (MANPRINT) primarily focuses only

on the physical characteristics of humans and how they can better interact with their equipment.

As of March 1996, the GEN II Soldier Program and the 21st Century Land Warrior program have merged into the Consolidated Land Warrior (CLW) program. The CLW Program, Natick Labs in Massachusetts, Motorola Inc., and Hughes Aircraft Co., are currently working on the material side of the soldier as a system concept.

> Their goal is to demonstrate enhanced soldier lethality and survivability with lighter weight and more robust equipment than was demonstrated in the Soldier Integrated Protective Ensemble (SIPE) Advanced Technology Demonstration (ATD). This will be done by linking technologically advanced dismounted soldiers directly to the battlefield through a digitized command and control network. GEN II Soldier is the follow-on to the SIPE ATD and the foundation on which the 21st Century Land Warrior (CLW) program will be built. These programs will integrate enhanced electronic components, individual equipment, advanced weaponry, and hazard protection items into a balanced and unified soldier system. This will provide situational awareness and automated target hand-off capabilities to individual soldiers. This system will consist of five modular subsystems which will provide flexibility and adaptability and will also allow mission tailoring without the burden of soldiers wearing or carrying items unnecessary for the mission. [Ref. 1:p. 1] [Ref: 2]

Another source for the research was the Army Science Board's vision for the concept of the Soldier System. The Army Science Board published the report "Ad Hoc Study Technology for the Future Land Warrior" in October 1994. [Ref. 9:p. 1] The study had three purposes. The first purpose was to identify high-payoff technologies. The second was to recommend programs to overcome technical and system barriers. Examples for these two purposes were the squad radio, global positioning system, the continuous positive pressure nuclear, biological and chemical mask blower, infrared laser aiming light, and Lower Extremity Assistance for

Parachutist (LEAP). The third purpose was to recommend appropriate demonstration projects. These technologies were demonstrated by the SIPE and other Special Operation Forces (SOF) programs. [Ref. 9:p. 1] The study also looked at programs to overcome technical and system barriers to a future Soldier System which included a review of the acquisition process to allow integrated fielding of basic systems; an emphasis on weight control as a key hurdle; and cost controls, which limit single unit costs to less than $10,000. [Ref. 9:p. 1]

The study outlined six potential demonstration project areas: [Ref. 9:p. 1]

1. Location and target detection. This area demonstrated an array of electronic equipment with the focus on improved capabilities rather than expensive hardware.

2. Combined arms integration. This effort would use the Training and Doctrine Command (TRADOC) Battle Laboratories to determine which small unit capabilities will enhance total force capabilities.

3. Comparative power demonstration. This would prioritize near-term power sources and establish limits on equipment.

4. Improved airdrop demonstration. This project area would integrate LEAP technology with new parachute designs to provide safe high-speed, low-altitude airdrops.

5. New nuclear, biological, and chemical (NBC) equipment and other clothing and individual equipment. This project area would determine the best approach to integrating NBC equipment with the rest of the soldier's clothing.

6. Medical. This project area would concentrate on improved communications and trauma care.

There were seven general findings of the top-level study. [Ref. 9:p.5]

1. The SIPE demonstrations showed that new, important, and affordable technology-derived techniques can provide cost effective improvements in Land Warrior capabilities.

2. The new Land Warrior capabilities will have a profound positive effect on the Army's ability to perform future contingency missions.

3. There were three major barriers to implementing LW technology. The barriers were:

   a. The current acquisition system (1991)

   b. Weight

   c. Cost

4. LW equipment must be issued in large quantities in order to be effective and that the soldiers must be fully trained to take advantage of the new capabilities.

5. Specific focus areas which set priorities for the soldier system are not defined.

6. Unclear descriptions of new capabilities are limiting the ability of LW technology to be fielded and compete with other programs.

7. The Army does not have a top-down new product planning process typical of high technology U.S. commercial business.

The panel found that technology for the future Land Warrior is available today. The panel also stated that developing and integrating technology for the future Land Warrior was not an impossible task, but that it would require a top-down management focus on results, not just creation of more programs. [Ref 9:p. 2]

Another source of background information on the soldier system was the Army Science Board "1991 Summer Study Final Report Soldier As A System." Six issues were raised during the study: [Ref 10:pp. 2-3]

1. The requirements for soldier materiel and performance should be driven by the future threat.

2. Currently (1991), the absence of formally derived requirements has allowed available technologies to drive soldier research, development, and acquisition processes.

3. The Soldier System must have an integrated and modular approach. Recommend a General Officer Manager for the development of soldier system items.

4. A systems architecture must be developed for the Soldier System.

5. Numerous potential opportunities for soldier performance enhancement exist and must be assessed.

6. Pledge continued support for the continuation of the Soldier Integrated Protective Ensemble Advance Technology Transition Demonstration.

One of the findings from the study was that "SOF provides a strong user pull for future Soldier System capabilities." [Ref. 10:p. 18] It also stated that "requirements for Special Operations missions in which the dismounted soldier still represents the most significant element of the mission, will likely be maintained or even intensified." [Ref. 10:p. 18] Therefore, SOF needs to have access to advanced technology soldier equipment because of their critical mission profile.

Another source of background information was the "HARDMAN III Analysis of the Land Warrior System" released in 1995 by the Army Research Laboratory. The analysis found that the Land Warrior equipment was value-added to the infantry squad. The squad leader benefitted in improved capabilities for command, control, and navigation. The downside was that Land Warrior equipped soldiers would need to carry equipment and supplies that weighed more than recommended. For the squad member, these additional burdens came in terms of the added communications tasks

that must be conducted. For the squad leader, these costs consisted chiefly of communications management difficulties, because multiple radio nets would need to be monitored. [Ref. 8:p. 95]

The study also looked at environmental impacts on the soldier. The HARDMAN III analysis found that heat and mission oriented protective posture (MOPP) equipment had the most significant impact on performance time and accuracy of the Land Warrior mission, while cold and sustained operations have less significant effects. The study also ran an objective maintenance concept simulation for a light infantry battalion using Land Warrior equipment. The results showed that the objective maintenance concept for the Land Warrior is supportable. However, this simulation also showed that if the current maintenance concept were used, there would be a shortage of maintenance manpower. [Ref. 8:p. 95]

Another background source of information was current articles from "National Defense", "Army Times", "Army" magazine, "Armed Forces Journal International" and even "Popular Science." These articles gave a snapshot of research leading to the 21st Century Warrior. The "National Defense" article centered its information on current equipment modernization for the Special Operations soldier. [Ref. 15:p. 32] The "Army Times" has also published updates on technology upgrades and equipment issues for the soldier. [Ref. 33:p. 26] [Ref. 34:p. 26] The "Army" magazine article gave an overall view and update of the 21st Century Land Warrior program and efforts to modernize the soldier's equipment. [Ref. 16:pp. 53-56] "Popular Science" gave an overview of military technology being used to upgrade the equipment of the soldier and how the military is accomplishing this. [Ref. 13:pp. 60-64] "Armed Forces Journal International" gave a review of the GEN II Soldier System and the 21st Century Land Warrior. [Ref. 32:pp. 18-23]

Another source for background information is a thesis titled "Special Operations and the Soldier System: Critical Acquisition Issues" by Douglas W. Lessley in March, 1992. This thesis gives a good background to the issues of the Soldier System prior to the establishment of Soldier Systems Command and PM-Soldier. [Ref. 19:pp. 9-31]

A report generated by the Rand Corporation titled "Future Technology-Driven revolutions in Military Operations" gave a general direction of where technology can help the future soldier as well as possible directions for the Soldier System to evolve. [Ref. 7:pp. 76-80]

G. QUALITY OF LIFE

The second aspect of research literature concerned Quality of Life aspects for the soldier, the soldier's family, and the potential effects it has on soldier performance and retention.

One source was the "Report of the Defense Science Board Task Force on Quality of Life" published in October 1995. This report outlined aspects of quality of life that were taken from a survey with service men and women across the United States and abroad and then presented its findings and recommendations for major improvements of housing, personnel tempo (PERSTEMPO), and community and family services. [Ref. 18:pp. 1-14]

Another source was the study conducted by the U.S. Army Research Institute (ARI) for the Behavioral and Social Sciences titled "Family Impacts on the Retention of Military Personnel." One of the most consistent findings in this study is the positive and significant relationship between spouse support and the retention intentions and behavior of Armed Forces personnel. The study found that the retention of service members is higher among those with spouses who support their decision to stay in the service compared to those with spouses who do not. [Ref. 28:p.

3] Another finding was that spouses who are most dissatisfied and who are likely to encourage the service member to leave the military are those spouses who are unemployed and looking for work. [Ref. 28:p. 5] Another example cites an investigation of retention differences at installations with high and low quality family support programs, significantly higher retention rates were found at installations with better quality programs. [Ref. 28:p. 7]

Another source of literature was a report published by ARI titled "Family and other Impacts on Retention." The results indicate the importance of family concerns and what impacts them as a basis for a soldier staying in the service. Factors such as; time for family activities; interference of work with family concerns; predictability of work hours and demands; and the quality of the army community as a place for families; were all important in a soldier's decision to stay in the service. Spouse involvement and support are also critical to a soldier's decision to stay in the Army for an additional term or for an entire career. [Ref. 6:pp. v-ix]

In a thesis titled "An Analysis of the Factors Affecting the Career Orientation of Junior Male U.S. Army Officers," the results indicate that factors such as length of service, commissioning sources, and other factors such as personal freedom, friendship, coworkers, patriotism, job dissatisfaction, job training, job security, and working conditions have strong effects on the career orientation of junior officers. Further, early junior officers are affected by the package of retirement benefits, but the longer they stay in the service, the more they are affected by factors related to family. [Ref. 25:p. iii]

H. UNITED STATES ARMY SPECIAL OPERATIONS COMMAND (USASOC)

The third part of the research was to review the structure of Army Special Operations Command and the generic base operation functions located at a typical

Army installation. The source for the Army Special Operations organization is Field Manual (FM) 100-25, Doctrine for Army Special Operations Forces, which gives a breakdown of non-classified Army Special Operations Forces, structures and the relationships among the different units. [Ref. 24]

The "1996 Handbook for Military Families" helped to outline some of the services provided to the soldiers and their families at each post. In addition the Internet provided many examples and information on the structure of and functions of present and future base operations. [Ref. 17]

I. SYSTEM ARCHITECTURE

The fourth part of the research was to create an architecture for the ARSOF Soldier System. The model or system that was used was based on object-oriented structures; for example "Object Oriented Analysis" by Peter Coad and Edward Yourdon which provided an overall approach to using their model for the soldier system. Another helpful reference in building the basis for the Soldier System Architecture was the text "Object-Oriented Software Engineering" by Ivar Jacobson. His approach was slightly different to the Coad/Yourdon approach, but it did show that there is more than one way to create an object-oriented system architecture. [Ref. 5] [Ref. 23]

J. COST MODELS

The fifth part of the research was to determine if the system architecture could be applied to some type of costing model in order to be able to determine soldier unit costs and the costs for a future soldier system. The sources for this information were "An Introduction to The Force Cost Model" from the U.S. Army Cost and Economic Analysis Center and the "Special Operations Force Cost Model" version 95.0. [Ref. 20, 21, and 22]

K. LITERATURE REVIEW SUMMARY

The various sources of literature on the soldier, quality of life, and organizations, cost models, and object orientation showed that each took an aspect of the soldier or a topic in relation and investigated it in detail. There was no literature which combined all of these factors under one publication. This thesis will make the effort to link these sources together for the ARSOF Soldier System.

II. ARSOF SOLDIER SYSTEM ANALYSIS

A. SYSTEM ARCHITECTURE ISSUES

There were many different issues to consider when constructing an architecture model for the ARSOF Soldier System. These issues were:

1. Determining what would become part of the system architecture.

2. Determining what would be the boundaries for the Soldier System.

3. Methodology to arrange the items that were considered for the Soldier System.

4. What type of system approach would be used to construct the architecture.

5. Determining how many levels to go down the architecture.

6. How to integrate quality of life issues into the ARSOF Soldier System architecture model.

7. Determining what part of the ARSOF Soldier System can USASOC control or have influence over.

8. Determining if this model could be applied to a cost model to determine unit costs per soldier.

B. CONSIDERATIONS FOR THE SYSTEM ARCHITECTURE

The first issue to consider was what ideas, equipment, systems, organizations, and other issues would become part of an architecture of the ARSOF Soldier System. The methodology I used was to list everything that had any type of relation to the soldier (see the appendix). This entailed using the concept of "thinking out of the box" meaning that items which normally or traditionally are not considered were added onto this list. This large listing was then subdivided into groups of items which

had similar characteristics and which also were further subdivided into even smaller related groups. These small and large groups were compared to form a picture of what categories of items, systems, and functions were a contributing part of the soldier. [Ref. 12 and 14]

Some of these categories already had similar groupings from other current military programs. For example, the GEN II Soldier program already had similar groupings already constructed by its program. The GEN II Soldier System ATD of the 21st Century Land Warrior programs consisted of: the integrated Headgear Subsystem (IHS), the Individual Soldier's Computer/Radio (ISC/R), the Weapon Interface Sub-system (WIS), the Protective Subsystem (PS), and the Interface and Power Subsystem (IPS). Each of these subsystems had equipment which made up these sub-systems. [Ref. 1:p. 1] [Ref. 3:pp. 1-3] [Ref. 4:p. 1]

There were also considerations of what to include about the soldier himself, such as a soldier's capabilities, limitations, and physical aspects. Other factors considered were the mental capability and morale of the soldier. In addition to this were the role of the family and the soldier's leadership.

The structure of the organization that the soldier worked and lived in was also listed as a factor which had a role to play in a possible architecture. This considered the environment that the soldier was operating in and what effect that environment had on his ability to perform his mission.

C. BOUNDARIES OF THE SYSTEM

The second issue was designating a limit to this large listing of equipment, systems, behavior, and organizations, since essentially everything eventually can be tied to the soldier in one way or another. A distinct relation of this listing to the soldier had to be developed in order to get a focused and ordered structure established. For example, the term "medical care" for the Soldier System would not

include the physical location and buildings of a major hospital even though a hospital is related to medical care and the soldier.

The identification of the Soldier System problem domain was done by looking at the various groupings and finding the overall relation that they had to each other. Nouns related to Special Operations and the soldier were collected, and pictures were drawn to tie them together. These words helped to provide some clues for potential components for the system. [Ref. 5:p. 60] More pictures of block diagrams, interface diagrams, system component diagrams, and macro-level diagrams were collected. Pictures were drawn, using icons and lines between them, as initial sketches of the problem domain and how the pieces interacted with each other. [Ref. 5:p. 60] This helped to gain a broader perspective of the problem domain at hand.

D. ORGANIZING ELEMENTS

The third issue was how to organize the elements into some sort of logical order once they had been selected. Some elements in one grouping or category could belong in another. Some elements would take on a different meaning when aligned in a different category. For example, the item "immunization" may be listed in the "medical care" category or it may also be listed under "protection." The subject of quality of life arose as to whether it should have its own class or include items within it that should be put under other already existing categories. The decision had to be worked out to which portrayal would be more effective. Quality of life was split up under this architecture model because it fit into the problem domain in a more logical manner. [Ref. 29]

Other questions arose as to whether the classes should be arranged by functions, capabilities, or by some other means. There are many ways to logically arrange the various items that are listed as being important to the soldier. Arranging by function implies that everything performs some type of procedural task. Not

everything does that. Arranging by capability is more encompassing but may also leave out some functional tasks. [Ref. 29] Object-oriented analysis helps to alleviate this problem by giving the system the flexibility to accommodate functions, capabilities, items, behavior and other categories. Object-oriented analysis will be further discussed in Chapter III.

E. TYPE OF SYSTEM ARCHITECTURE

The fourth issue was once the items were designated what kind of system architecture would be used? Four models of system architecture were looked at closely. The first model, the Coad/Yourdon model, utilized object-oriented analysis for the construction of its system architecture and broke its system down into objects and classes which could be organized in relation to the soldier system. The second model, utilized by Ivar Jacobson, is also object-oriented based but is more flexible than the Coad/Yourdon model. These two models were utilized primarily for the ARSOF Soldier System. The third model considered, the Hatley-Pirbhai method, depended too much on the use of time within its system in order to be effectively used for the proposed ARSOF Soldier System. Its method was functionally based and linked these functions with the application of time constraints to its method. It also linked a set procedure for things to be done, which is not always the case with this system. A fourth model, using Data Flow Diagrams and the Context Flow Diagrams, was also studied. This model was not further considered because of the difficulty of incorporating quality of life issues and soldier behavior. This model was also dependent on functionality of system and thus was not open for other types of potential objects to be added to this system.

F. DEPTH OF SYSTEM DESCRIPTION

The fifth issue was how far down a system architecture should this particular model describe? Breaking a structure down by layers can become complex and also

very large. The model could descend many layers depending on which subject area one was talking about. As a person studies a system, he or she will start from general categories and move to specific detailed categories as they study further into a system. The general categories and classes were not difficult to list. The difficulty started to arise when I started to study the categories in detail. Each detailed category contains information for which one individual does not have expertise in and thus must rely on people whose specific expertise lies in that particular category. For example, an Intelligence specialist is not going to have in-depth knowledge of the logistics part of ARSOF Soldier System. The attribute layer was the last layer described, but it was deliberately left blank, or it was generally labeled to give an idea to the reader of the level of detail or complexity that the attribute was describing.

G. QUALITY OF LIFE ISSUES

The sixth issue was how to utilize Quality of Life (QOL) issues for the soldier system on this model. There are various systems that are designed to support the soldier and his family in peacetime and also in combat. The pattern for the functions of these QOL sub-systems appears to show that they are set up to keep the soldier and his family relatively satisfied (sustainment) and to fix their problems (maintenance). These QOL systems are critical in the short and long run for Army Special Operations. In the short run, the soldier may become dissatisfied with his quality of life in the service. This will affect his morale, and the soldier will not operate at acceptable levels. In the long run, the soldier system may irreparably break down in one of the sub-systems, which may cause the soldier not to reenlist. This means wasted investment. The key is to weight the QOL issues having the most effect and to ensure that these are handled carefully in the future so that the soldier can operate at optimal performance.

H. CONTROL AND INFLUENCE

The seventh issue was what part of the ARSOF soldier system can USASOC control or influence? USASOC wants to determine how much control would it have over the proposed ARSOF Soldier System. There are many parts of the ARSOF Soldier System that are common to the rest of the U.S. Army or are parts of other Services. This issue may come down to who funds the various components of the ARSOF Soldier System. Whatever USASOC has funding control over is what it can ultimately control on the system. The command can have influence over events it does not control, but it ultimately comes down to who has the funding dollars for what part of the system. This issue will be briefly addressed in Chapter IV.

I. COST MODELS

The eighth issue was if cost models could be applied to this type of system architecture. The issue was raised by the USASOC Director of Combat Developments if a cost system could be applied in order to determine a unit cost for each soldier in tying in all the aspects of the ARSOF Soldier System. The cost system was applied only because a cost model had already been developed for the soldier system. The cost system has not been applied directly to the ARSOF Soldier System, but it possibly could be utilized if the program were modified. Since the architecture was different from others proposed, it is not determined if a cost could be applied to qualities such as behavior and morale. Though the Special Operations Forces Cost (SOFCOST) model has not gone into those issues specifically, the flexibility of object-oriented structures gives the possibility that a cost model could be constructed.

J. BASIS FOR SYSTEM ARCHITECTURE

The basis for the architecture for this proposed ARSOF Soldier System is a systems engineering approach to building a system. This method is the same way that other material systems are designed. This way the ARSOF soldier has the same basic

system architecture as a tank except there are more human and quality of life systems that are integrated. There are two steps that will lead up to the description of the system architecture in Chapter III. The first step is to identify what are the goals of the system. The second step is to outline how these goals would be achieved.

K. GOALS OF THE ARSOF SOLDIER SYSTEM

There are eight overall goals that are recommended for the Soldier System. These goals are an adaptation from goals from the GEN II Soldier System and the key system factors from the Rand study on SOF performance enhancers for the individual soldier. [Ref. 7:pp. 80-85] These modified goals [Ref. 1:pp. 1-3] are:

1. Improve lethal and non-lethal weapons and doctrine
2. Improve situational awareness
3. Improve survivability
4. Improve command and control
5. Improve mobility
6. Improve soldier contributions to combined arms operations and force effectiveness
7. Improve soldier quality of life
8. Improve recruiting and retention

L. IMPROVING LETHAL AND NON-LETHAL WEAPONS AND DOCTRINE

Webster's *New World Dictionary* defines lethality as "causing or capable of causing death" [Ref. 26:p. 775]. Improving lethality means taking present weapon systems and improving them so that they have a capability that is more destructive than the enemy's weapon systems. Lethality systems are the primary means used by

the soldier against the enemy. The soldier also needs to draw on a more varied array of weapons in order to scale his response correctly.

Non-lethal methods enable the soldier to deter or delay the enemy without causing death. Different missions call for an appropriate response to a particular situation. A direct action mission will call for weapons that destroy personnel and equipment. A peacekeeping mission may entail a mix of weapons that destroy personnel and equipment but also use non-lethal weapons that deter instead of destroy. Chemical Smoke (CS) grenades and smoke can deter a force without masks from advancing or attacking. The Marine Corps, in the evacuation of Mogadishu, Somalia, used weapons that shot out a thick layer of a sticky substance which impeded the enemy's movement and allowed for an uninterrupted evacuation. [Ref. 31:p. 74]

M. IMPROVING SITUATIONAL AWARENESS

Improving soldier situational awareness involves the methods used to keep a soldier informed on the battlefield. This ensures that the soldier has the ability to determine what is occurring around him in his operational environment. The soldier constantly needs information in order to make appropriate decisions. Traditionally soldiers have relied on their senses and judgment to understand a situation confronting them locally. Radios are used to send and receive information in order to increase a soldier's area of situational awareness outside the physical boundaries of the soldier himself. The radio is limited in the aspect that one cannot see with it. Video technology is rapidly improving to increase visual situational awareness. Sensors will also help to increase a soldier's awareness of his environment around him so that he can react correctly and quickly. Sensors such as chemical detection and mine detection equipment will get smaller so that they will be easily portable by the soldier.

N. IMPROVING SURVIVABILITY

The goal of survivability is to ensure that the soldier is protected against enemy fire, disease, and the environment. The primary goal is to protect the soldier against enemy fire. This includes small arms fire, indirect fire, nuclear, biological, and chemical (NBC), and other means such as laser and microwave energy. Another aspect of survivability concerns the debilitating effects of disease and illness. Soldiers that succumb to illness and disease are ineffective or are at best marginal on the battlefield or operational environment. Methods that can be utilized are education, avoidance of risky behavior, preventative, and restorative measures. Education can make the soldier aware of diseases endemic to a country or what simple measures to take in the case of illness. Avoidance of risky behavior, such as drinking untreated tap water in a third world country, can help to prevent contracting illness or disease. Preventative measures include immunizations against potential diseases, protective clothing, and protective lotions such as n-diethyl-m-toluamide (DEET) against ticks, and sunscreen for the skin. Restorative measures are the medical drugs and efforts taken to restore the soldier's health after he has become ill. Restorative measures will repair the soldier's health so that he can recover and perform his mission.

O. IMPROVING EFFECTIVE COMMAND AND CONTROL

Effective command and control ensures the right mix of forces in the right place at the right time. The focus of command and control is to integrate individual soldier actions, unit actions, and the command structure to efficiently perform a mission. Command and control at the individual soldier level will concentrate on the mechanisms that allow the individual to be controlled by his chain-of-command. The command and control functions will concentrate on the structure and mechanisms that a command would use to control its forces. Command and control is essential in a future force that is fewer in number but still as lethal as a larger older organization.

P. IMPROVING MOBILITY

The goal of improving mobility is to ensure that the soldier can move quickly with as little loss of endurance and strength as possible. Soldiers can move by air, by land, or by sea. Soldiers move in the air typically through the use of fixed-wing aircraft and rotary wing helicopters. The advantage to this method is speed and accessability, with refueling, to virtually every location on earth. Air-delivery methods are how the soldier arrives at his location from the air. The soldier can air-land, parachute, rappel, and fast-rope to his location. The soldier can be extracted through a hoist, rope ladder, and the Fulton recovery system.

On land, the soldier can move by foot, by animal, or by some powered vehicle. Moving on foot is the method that the soldier must always be ready to rely on when all the other modes of mobility fail or are not available. Movement by animal is not common today, but it has been used in extremely mountainous, desert, or dense jungle environments. [Ref. 35:pp. 12-13] Powered vehicles are the common method of land transportation and offer the soldier various cargo and personnel carrying variations. Trucks, High Mobility Multi-purpose Wheeled Vehicles (HMMWV), automobiles, All Terrain Cycles (ATC), motorcycles, and even bicycles are examples of land transportation that can be utilized.

Mobility by sea involves moving on the water and also underwater. Swimming is the base skill needed by the Special Forces soldier to move on top of and under water. Soldiers may also move on the surface by Klepper kayak, folding kayak, rubber boat, or patrol boat. Underwater, the soldier can move by using Self Contained Underwater Breathing Apparatus (SCUBA) or by traveling in or on a mini-submersible.

Q. IMPROVING SOLDIER CONTRIBUTIONS

The goal of improving soldier contributions to combined arms operations and force effectiveness is to improve the structure from which the soldier operates. Examples of improvements are the restructuring of a unit's organizational structure or utilizing simulation in training modules. Force XXI initiatives are making great efforts through their Battle Labs to improve organizations, training, doctrine, and the soldier. Training is also utilized to improve the soldier's contributions. Training is the improvement of a soldier's war fighting skills. These skills need to be taught at the individual and unit level.

R. IMPROVING QUALITY OF LIFE

The goal of improving quality of life is to provide for a positive environment for which the soldier, his leadership, and his family can live. The family and the leadership above the soldier are key factors in the ability of the soldier to effectively fight on the battlefield. If the soldier's family is not happy or is having problems, the soldier will be distracted and not be able to fully perform his mission. [Ref. 36:pp. 17-18] Leadership must also be competent in order to optimize the abilities of each soldier. A poor leader will blunt the motivation and morale of a soldier very easily. A soldier's morale, experience, and inherent abilities all play a key role in the performance of the soldier. A soldier's experience helps him to confront new situations or to solve old routine situations that are encountered. A soldier also has inherent mental and physical capabilities. A tall large soldier will probably be able to carry a heavy rucksack farther and faster than a soldier who is small and short. Because USASOC faces an ever-increasing complex military and world, it will need intelligent soldiers who can master many subjects, are well trained, as well as educated. Soldiers with low mental capacity will not be able to properly utilize all the

equipment that they will need to survive and accomplish his mission on the battlefield.

S. IMPROVING RETENTION AND RECRUITING

The goal of retention and recruiting is to locate those personnel with the requisite skills and to attract them into Special Operations. Special Operations needs intelligent, healthy, trained, and motivated soldiers. Training a Special Operations soldier is a long and expensive process. Therefore, it is incumbent upon the organization to recruit those individuals who have the best chances of succeeding. Recruiting and training soldiers who have health problems, low Intelligence Quotient (IQ), or are not motivated will take longer, be more expensive, and they will be less likely to accomplish their mission. Once a soldier has been recruited and trained, it is imperative that the command makes the effort to retain the soldier within Special Forces. This can be done with various incentives such as specialty pay, better promotion rates, important job positions, and family benefits.

T. HOW TO ENHANCE THE SOLDIER SYSTEM

1. Equipment Enhancement

Achieving the above mentioned goals can be accomplished by enhancing three categories which affect the soldier. The three categories are: enhancing the equipment of the soldier; enhancing the soldier himself; and enhancing the structure of the soldier.

Enhancing the equipment of the soldier is the category in which most of the acquisition and research and development efforts have been conducted. Enhancement of equipment means the research and development effort taken to improve any materiel aspect that directly affects the soldier. Materiel associated with the soldier is the most tangible part of the soldier system. Integration of the various pieces of equipment so that they are lightweight, compatible, and effective are the challenges

faced with this part of soldier enhancement. Within this category are the lethality, command, control, and communications (C3), survivability, and mobility sections. A part of the medical subsystems can also be included in such a category. Enhancing lethality can be done by improving the weapon systems for our soldier. This means making the weapons lighter, more accurate, and the munitions more lethal per round. Other improvements that can be made are making the ammunition lighter and easier to carry. Research is being conducted on consolidating weapons such as the shotgun and the rifle into one weapon. Laser energy and microwave energy are also being looked at for possible inclusion into future weapons. Non-lethal weapons will focus on making a portable, lightweight, and accurate weapon which will deter, disable, or delay an enemy. This type of weapon is also needed for missions in which loss of life on the enemy side will have a negative effect on the accomplishment of the mission.

Enhancements in the C3 field will revolve around the physical hardware of radios, Global Positioning System (GPS), transponders, receivers, and flat panel displays to name a few examples. The command, control, and communication system is being improved by the digitization of the battlefield and the other improvements in communications hardware. The soldier will be able to access more and more information in order to have a greater situational awareness of the battlefield. The chain-of-command above the soldier will be able to monitor information from various sources to include the soldier. The commander will then be able to ascertain where all of his forces are and to ensure that they are deployed correctly.

Survivability enhancements for the materiel category will involve protective features for the soldier. Protective clothing and equipment can be improved by developing new fibers and materials to protect the soldier from concussion, shrapnel, NBC agents, and small arms. Most materials will have one or two protective features so the soldier will carry various materials to wear at the appropriate time in order to

have maximum protection. These systems would be lightweight, conform to the body, non-toxic, and configurable.

Mobility systems can be improved to transport the soldier to his mission location quickly and stealthily. Mobility systems for the materiel aspect will concentrate on the traditional types of vehicles used on air, land, and sea for the soldier. This will help to increase the soldier's endurance, strength, and ability to accomplish his mission after carrying a mission load over a prescribed distance. Systems can also be made lighter to improve the burden carried by the soldier. There are obvious advantages to having mobility systems for the soldier, but there are also major drawbacks which must be considered in supporting the soldier. The main drawback of these mobility systems are that they increase a soldier's logistical tail, increase the soldier's noise and profile signature, and increase the soldier's support costs in materiel acquisitions.

Medical equipment systems can be improved for the soldier to treat wounds and diseases on the spot instead of being evacuated to the rear. Medical diagnostic and trauma care equipment can be developed to save a soldier's life on the battlefield. Monitoring equipment can also be utilized to ensure that a soldiers's health and combat capability are kept in the effective range. These types of systems must be lightweight and able to stabilize the soldier until he can access other systems in the rear of the battlefield.

2. Soldier Enhancement

The second category of enhancing the soldier system is by improving the soldier himself. This category is further divided into seven areas:

1. Recruit the best soldier
2. Develop the soldier

3. Improve a soldier's Military Occupational Skills (MOS)

4. Improve the soldier's endurance and strength

5. Protect the soldier's health

6. Maintain high soldier morale

7. Retain the high quality soldier

Recruiters need to know what type of physical characteristics that Special Operations need. Are they looking for people who have great strength or are they looking for people with great endurance? They also need to look at size or potential of a soldier. Is a short soldier going to be able to carry all the mission loads considered for a Special Operations mission? Another consideration that recruiters must consider is determine the intelligence of the applicant soldier. Soldiers with slow learning capabilities or low IQs will be too expensive to train for Special Operations. Since Special Operations are complex and require a greater amount of training, they require soldiers who are intelligent and capable of rapid learning.

The second section is to develop the soldier. This means taking the soldier and developing him into a leader. The soldier needs to learn how to lead others so that he can optimize his soldiers' and his own abilities. A leader has to know what his soldiers' needs are in order to ensure that all aspects of the soldier system are being properly utilized. Soldiers need to be developed in order to reach their maximum potential and to know how they fit in an organization and how it will accomplish its missions. A soldier also needs to learn what the Army and Special Operations cultures expect. Special Operations has its own distinct culture, and a soldier needs to know what is valued over other aspects. The soldier needs to be mentored from his immediate and higher supervisors so that he can learn from their mistakes, experience, and observations.

The third section is to improve a soldier's MOS skills. The soldiers assigned primary combat skills must be taught and honed to a sharp edge for the soldier to be effective. This is done through training at basic, Advanced Individual Training (AIT), and at specialty schools. These help to train in general skills in basic areas for the soldier to maintain. The unit conducts specific training to tie in the MOS skills to their assigned combat mission. The soldier also needs to maintain those MOS skills that are not regularly used for the mission at the time. The soldier enhancement section will provide the structure, priority, and standards that a soldier needs to maintain his MOS skill in Special Operations.

The fourth section is to improve the soldier's endurance and strength. The soldier can improve his strength through an active strength training program. This helps for the soldier to be able to carry the equipment at the time of mission performance. Endurance must also be combined with strength to get the best mix of strength and endurance. Strength and endurance training helps to maintain a healthy soldier, reduce injuries, and reduce training accidents. The goal is to have a soldier who can carry a heavy combat load a great distance, perform his mission, and return to his base.

The fifth section is protecting the soldier's health. This can be done to make sure that the soldier is getting a proper diet to help maintain a strong and healthy body. Proper sleep and stress relieving techniques are also needed to ensure a soldier's good health. Immunizations and proper use of medicines can be used to protect the body from diseases and prevent other afflictions that can attack and physically weaken or incapacitate the soldier.

The sixth section is maintaining high soldier morale. This is a key aspect of enhancing the soldier. The soldier must be in the right frame of mind and morale in order to be 100% effective. Morale has a great effect on his combat effectiveness.

A healthy, strong, well-equipped, and trained soldier can totally fail if he is not truly motivated to accomplishing his mission. The organization, leadership, and a soldier's family must recognize when there are morale problems with the soldier. Resolving morale problems are difficult for the structure of an organization. Resolving morale problems are key to getting the soldier back into combat effectiveness.

The seventh section is retaining the high quality soldier. Special Operations selection and training of a soldier is a long-term and expensive process which takes years before a soldier is truly considered well-trained. USASOC cannot afford to have a high turnover rate because of the loss of training effort spent and the loss of the experience gained from the soldier. USASOC needs to make every effort to retain its best soldiers through promotion, benefits, and other opportunities. Today, many positions in Special Operations go unfilled because there are not enough qualified individuals to take those positions. These are positions in which standards cannot be lowered or the risk of mission failure would increase. The increasing complexity of Special Operations and the Army as a whole has created a demand for highly-trained individuals. These individuals, once they have entered a Special Operations unit, must have the opportunities for experience, promotion, and duty positions which will promote success.

3. Structure Enhancement

The third area of the soldier system is to improve the structure of the Army, USASOC, and Base Operations (BASOPS) which directly affect or influence the soldier. Coordinating and integrating these systems with the soldier will provide a unified effort towards mission accomplishment and optimizing the use of the soldier on the battlefield. There are four parts to the Structure Enhancement of the soldier system. These four parts are:

1. Organization

2. Services

3. Logistics

4. Training

The first section of structure enhancement is the organization. The organization must be set up to take advantage of the soldier system and to help support the soldier. USASOC and United States Army John F. Kennedy Special Warfare Center and School (USAJFKSWCS) are organized to provide soldiers and to train the soldiers with their systems. When new technology is introduced, it is the responsibility of the organization to see if new technology can be utilized for the soldier. Approved new materiel systems will then be obtained to equip that soldier. The organization is also responsible for aligning the base operations and other non-special operations organizations in the proper structure so that they can provide timely and full support to the user. These BASOPS organizations provide critical services to the soldier, the command, and the soldier's families. Services such as post housing, engineers, maintenance, Morale, Welfare, and Recreation (MWR), libraries, commissaries, Post Exchanges (PX), and clothing sales stores all provide critically needed services for the soldier and his family. These services also have a key factor in morale and the perception of quality of life. These offices operate under the guidance or in affiliation with the BASOPS command structure.

The second part of the structure is the providing of the services itself. Services that have an effect on the soldier must be identified and prioritized. These services range from career management to family and social counseling programs.

The third part of the structure are the logistics provided. These range from fueling, fixing, distributing, and arming. Fueling in the aspect of the soldier system

deals with the energy needed to power the equipment of the soldier system. For the soldier this could be the acts of eating and drinking. Fixing refers to the repair of the system equipment and materiel. Arming is the act of providing ammunition and weapons to the soldier. Distribution is the system of how supplies and services are provided to units that are separated by close or long distance.

The fourth part of the structure is the function of training. This involves the physical act of training and the organizations that are set up to ensure that the soldier is trained for combat at the individual, unit, and leader level. The Special Warfare Center is responsible for the policies and structure of training. This organization ensures that training programs are aligned for the maximum preparation of soldiers in doctrine, tactics, and use of new equipment in the field.

U. SUMMARY OF ENHANCEMENTS TO THE SOLDIER SYSTEM

It is stated from the three previous sections that the soldier system basically consists of three overall areas: materiel, structure, and human resources. Covering just the equipment portion will leave out these other components of the soldier. It should also be noted that each of these three sections do not operate in isolation from one another; they are constantly interacting to provide the information or to support an action of the other. Also, some actions will blur as to what category that they belong.

III. ARSOF SOLDIER SYSTEM MODEL

A. OBJECT-ORIENTED STRUCTURE OF THE SOLDIER SYSTEM

The ARSOF Soldier System will utilize aspects from the Coad/Yourdon and Ivar Jacobson models of object-oriented structures. These models give flexibility to map and build an organization which reflects how it will work. Tangible and intangible objects are linked together. Systems using object-oriented structures will truly reflect the actions being conducted by the organization. Object-oriented structures are also flexible enough to adapt to changes without a great amount of rewriting or reorganizing the structure.

This chapter shows how problem domains, classes, objects, and attributes are designated for the ARSOF Soldier System. First, the layers of an object-oriented mode are examined. Second, the problem domain is identified. Third, classes are identified. Then, objects are identified and finally, attributes are identified.

B. OBJECT-ORIENTED MODEL

The object-oriented model consists of the following four layers: [Ref. 5:p. 54]

- Problem Domain
- Class layer
- Object layer
- Attribute layer

These four layers overlap one another and present more detail as one goes down the layers. One of the reasons for identifying and classifying items as a problem domain, class, or object, is to create a stable framework for analysis and specification. These items in the ARSOF Soldier System today will probably be the

same five years from now. Class and objects are meant to be stable over time, and they provide a basis towards future reusable results. But the attribute layers for the objects in those classes may change radically during that time. When a system is based on first categorizing by the problem domain, it helps to reduce volatility of the overall system design and reduce subsequent rework. The intent is to structure the overall system and specification strategy upon a framework that is likely to be much more stable over time. [Ref. 5:p. 54]

When one considers the Soldier System and the push for high technology, parts of the system will constantly change to reflect new threats and new technology. Interfaces between system components will be highly volatile because of these changes, as will functions and sequencing of functions. On the other hand, data will be less volatile because of advances in storage and retrieval. The problem domain, class, and objects will be the least volatile of all because they are the core of a system. Technology will not replace them but only improve them. [Ref. 5:p. 54]

C. SYSTEM CONTEXT

The object-oriented model also provides a description or layout of the system context. Context is not defined by a diagram drawn by a systems analyst making a technical decision. Rather, it is affected over time by leaders, staff officers, users, the threat, government regulators, and defense contractors. Further, it is an indication of how much of the whole concept or a portion of it will be embraced by the Soldier System, what information will be held over time, and how much system sophistication will be included. It's especially important to tie together all relevant materials and systems that have an effect on the configuration and composition of the Soldier System. [Ref. 5:p. 55]

Systems are affected by the quadruple constraint which examines what overall processes set system context. The formula is: Quadruple Constraint = Capability

+ Schedule + Budget + People [Ref. 5:p. 55]. To have full control of a system and to be effective, the commander or designated program manager must be accountable and manage effectively in all four of these areas. [Ref. 5:p. 55]

D. PROBLEM DOMAIN

Terms, functions, and organizations, in the abstract affect understanding and effective communication for the system. The problem domain must be understood first. It does not makes sense to start writing functional requirements without first understanding what composes the problem domain. [Ref. 5:pp. 53-54]

The first step is to define a problem domain, which is a field of endeavor under consideration. [Ref. 5:p. 52] It sets the general area in which the system will work and is usually very wide ranging and generalized, though it does have some definable limits.

E. ARSOF MODEL PROBLEM DOMAIN

The following system architecture model will start from the macro-level and work down three levels below that. The first issue is to identify the problem domains of the soldier system. This sets the context for which the soldier system is to be described and modeled. There are three problem domains that apply to the ARSOF Soldier System: *Materiel, Human Resources, and Structure*, as seen in Figure 3-1:

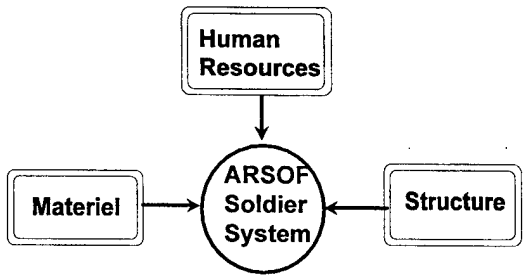

Figure 3-1. ARSOF Problem Domain

The first problem domain of the model is *Materiel* which looks at all aspects of equipment the soldier will wear or utilize. The purpose of this domain is to categorize the equipment used by the soldier. It is subdivided into two categories, the first including the initiatives conducted under the Soldier Enhancement Program (SEP), Soldier Integrated Protective Ensemble (SIPE), Generation II Soldier System, (GEN II), and the 21st Century Land Warrior (21st CLW) program. The second category is mobility systems. Figure 3-2 depicts, the Materiel problem domain.

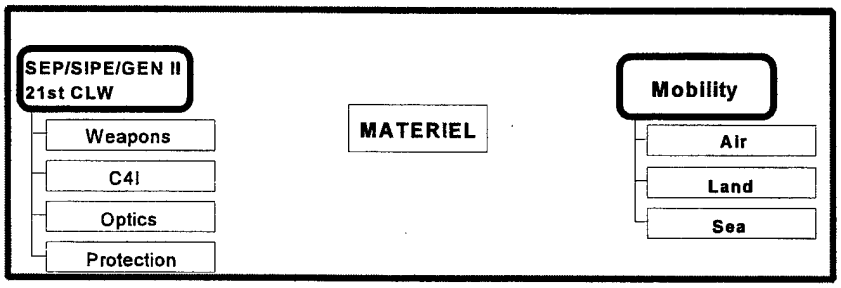

Figure 3-2. Materiel

The second problem domain of the model is *Human Resources*. This domain explores what categories of people are utilized or have influence on this part of the Soldier System. The three categories within this domain are: the soldier, his family, and his leaders. This domain looks into the inter-relationships of these three categories of people to find out how they relate to each other and how they interact with the other systems. The Human Resource domain is depicted in Figure 3-3.

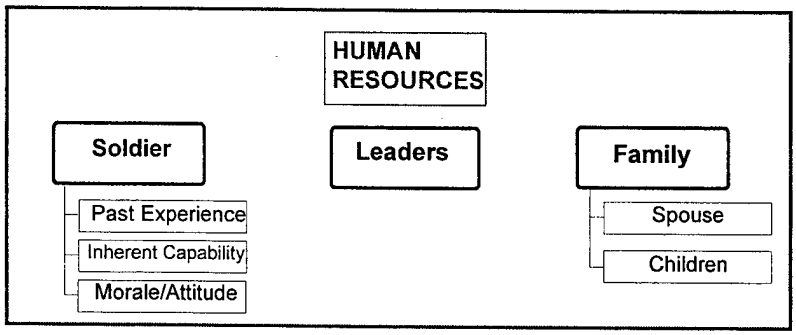

Figure 3-3. Human Resources

The third problem domain of the model is *Structure*. This deals with the categories of system structures that closely support the soldier which are broken down into organization, services, logistics, and training. The Structure domain is depicted in Figure 3-4.

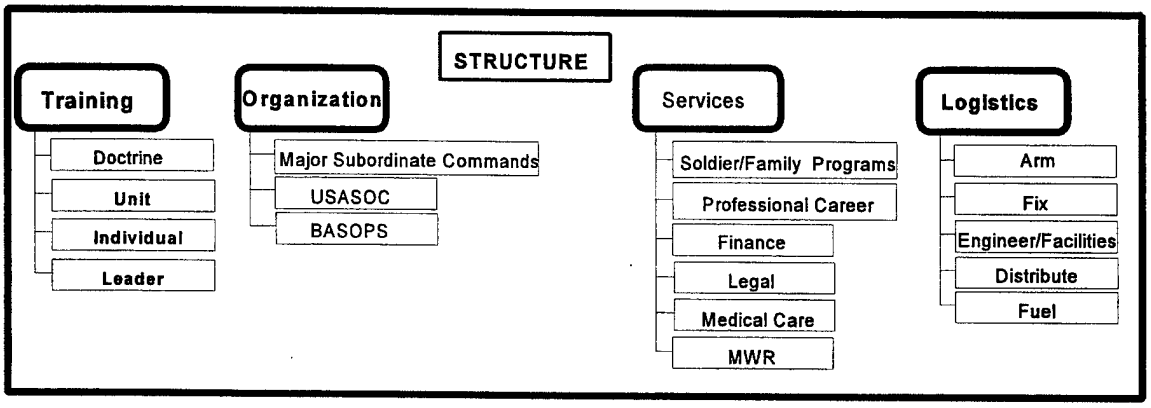

Figure 3-4. Structure

F. CLASS AND OBJECTS

The purpose for identifying class and objects is "to match the technical representation of a system more closely to the conceptual view of the real world." [Ref. 5:p. 53] Abstraction of the real world helps us gain and communicate

significant understanding of the problem domain for the system under consideration, with a view toward reusable analysis results. [Ref. 5:p. 54] Class and objects represent the initial expression of context. Subsequent object-oriented activities provide an increasingly detailed description of the context in terms of attributes. [Ref. 5:p. 55]

Another purpose for identifying class and objects is to avoid shifting the underlying representation as we move from systems analysis to design. At first, the gap between analysis and design seemed unable to be bridged. Shifting from an underlying network organization for analysis (data flow diagrams) to an underlying hierarchical organization for design (structure charts) has been very difficult and nearly always untraceable. The emphasis of design is taking the requirements and adding implementation detail. Adding a change in underlying representation has been the primary cause of the analysis design gap. [Ref. 5:p. 55] Object-oriented structures can resolve this dilemma by using an object-oriented representation in analysis, design, and implementation. It is not required in applying object-oriented analysis or object-oriented design, but is significant during implementation, maintenance, and reuse. [Ref. 5:p. 56] [Ref. 11:p. 287-288]

G. CLASS

In this model, there will be a number of communicating objects. Some of these objects will have common characteristics and can be grouped according to these characteristics. In order to describe all objects that have similar behavior and information structures, we identify and describe a class to represent these objects. [Ref. 23:p. 49-50] [Ref. 11:p. 290]

A class is a definition, a template or a mold to enable the creation of new objects and is a description of the common characteristics of several objects. The

class name is a singular noun or an adjective and noun. The objects comprising a certain class have this template in common; [Ref. 23:p. 50]

> A class represents a template for several objects and describes how these objects are structured internally. Objects of the same class have the same definition both for their operations and for their information structures. [Ref. 23:p. 50]

A class is defined as "a description of one or more objects with a uniform set of attributes, including a description of how to create new objects in the class." [Ref. 5:p. 53] The Soldier System diagram in Figure 3-5 depicts the classes that are derived from their respective problem domains, as seen in the outermost diagram blocks:

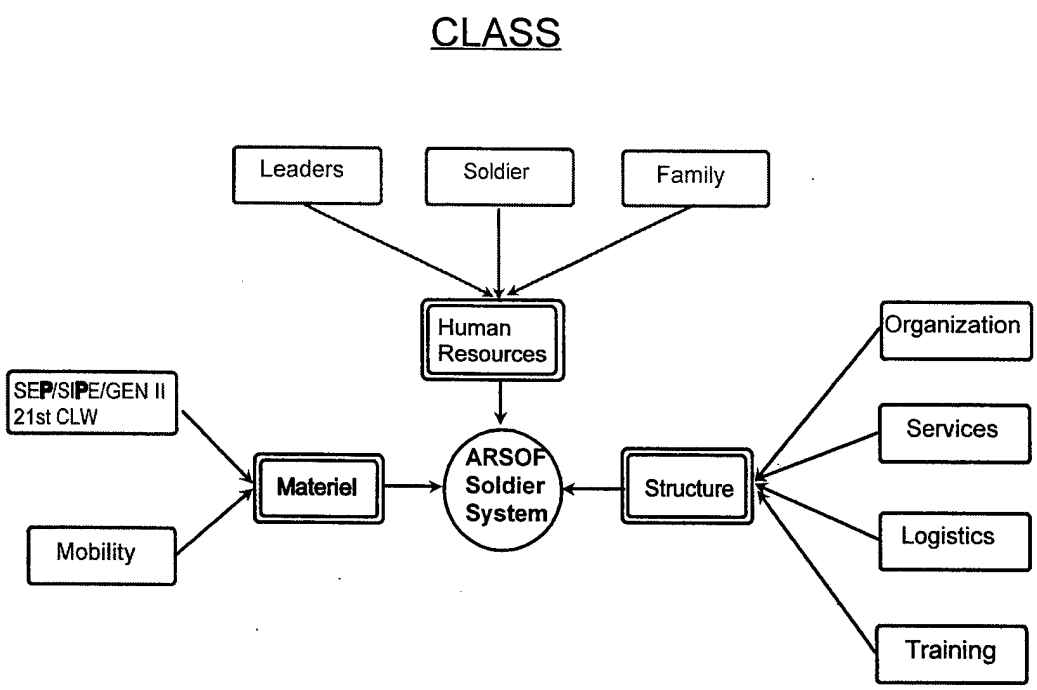

Figure 3-5. Class

New classes can be added by describing changes to existing classes, but may sometimes involve restructuring the inheritance hierarchy. By extracting and sharing common characteristics, classes can be generalized and placed higher up in an inheritance hierarchy. If a new class needs to be added, an existing class can be found that already offers some of the operations and information structure required for the new class. The new class can inherit the existing class and only add that which is unique for the new class. [Ref. 23:p. 58]

Classes lying below a class in the inheritance hierarchy are called descendants of the class. Classes lying above are called ancestors. If a class directly inherits from another class, it is called a direct descendant. The first class is then the direct ancestor of the second class. [Ref. 23:pp. 58-59]

H. OBJECT

An object is defined as an abstraction of something in a problem domain, reflecting the capabilities of a system to keep information about it, interact with it or both. [Ref. 5:p. 53] It is also an encapsulation of attribute values. "An object is an entity able to save a state (information) and to offer a number of operations (behavior) to either examine or affect this state": [Ref. 23:p. 44]

> An object is characterized by number of operations and a state which remembers the effect of these operations. [Ref. 23:p. 44]

An object-oriented model consists of a number of objects which are defined parts of the modeled system. Each object contains individual information, for example a weapon's weight, caliber, length, and weight. [Ref. 23:p. 44] The following Soldier System diagram in Figure 3-6 depicts "objects" as the outermost block diagrams of the system:

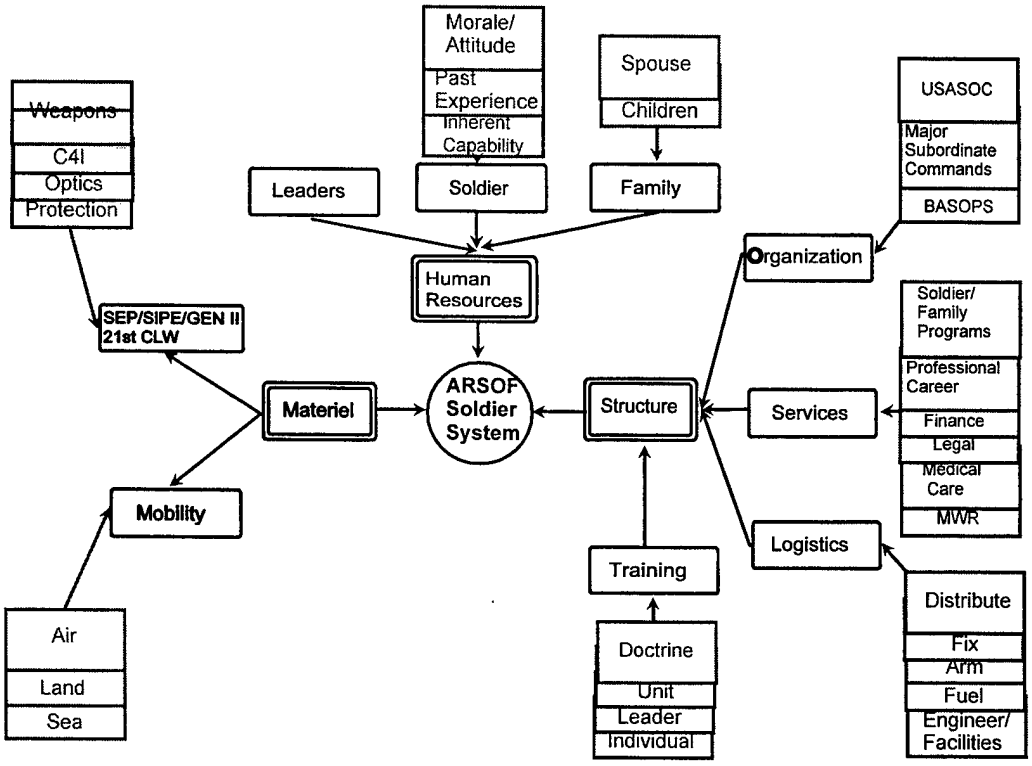

Figure 3-6. Objects Added to ARSOF Soldier System

I. ATTRIBUTE

In object-oriented structures, the term "attribute" is defined as reflecting both the problem domain and the system's responsibilities:

> An Attribute is some data (state information) for which each object in a class has its own value. [Ref. 5:p. 119]

At this point, the object-oriented model is more specific and more detailed. Each class and object is described in more detail with attributes which add detail to the "class" and "object" abstractions. Attributes describe values kept within an object, which can only be manipulated by the services of that object. [Ref. 5:p. 119-120]

Over a period of time, the problem domain, classes, and objects will remain relatively stable. However, attributes are more likely to change:

> For example, consider an "Aircraft" class within the problem domain of air traffic control. Currently, certain aircraft transmit both identification and altitude. Several years from now, certain aircraft will report a much broader bandwidth of data, including such things as rate of climb/descent, aileron positions, and on-board sub-system status; the system on the ground may know (by aileron positions) when an aircraft is turning, rather than having to guess (extrapolate) with radar returns only, as is done today. The "Aircraft" class will remain, but the number of attributes (and the sophistication of the exclusive services on those attributes) will change. [Ref. 5:p. 120]

J. INSTANCE

In object-oriented systems, each object belonging to a certain class is called an instance of that class.

> An instance is an object created from a class. The class describes the (behavior and information) structure of the instance, while the current state of the instance is defined by the operations performed on the instance. [Ref. 23:p. 50]

K. INHERITANCE

When classes are described, it is noted that many have common characteristics such as behavior and information structure. For instance, when the classes cars and trucks are compared, they are very similar to each other. These similarities can be shared between the classes by placing them in a separate class: vehicles. Common characteristics are collected into one specific class and then the original classes inherit this class. These characteristics that are specific to the original classes only need be described. [Ref. 23:p. 56]

L. SYSTEM DESCRIPTION

A system is defined as the organization of hardware, software, material, facilities, personnel, data, and services needed to perform a designated function with specified results. The diagrams and descriptions that will follow in this chapter will depict a breakout of possible class-descendants, objects, and attributes for each class for the ARSOF Soldier System. This system description is not meant to be all encompassing but is intended as a "strawman" system to provoke thought, discussion, and improvement. The ARSOF Soldier System is comprised of three problem domains and nine classes. Those classes are:

1. Training
2. Organization
3. Logistics
4. Services
5. The Soldier's Family
6. The Soldier
7. Leaders
8. Mobility
9. SEP/SIPE/GEN II Soldier/21st CLW

These classes are further broken down into objects, which are finally broken down into attributes. The problem domains, classes, and objects may be independent, related, or dependent on the other systems for their functionality. The inter-relationships give an indication of what can happen when a part of a system is cut back or canceled and how this affects the soldier.

M. TRAINING

Doctrinal training is the component that focuses on how the soldier fights. This method of training can be taught at individual, unit, and leader levels and centers around the teaching of warfighting principles. Special Forces doctrine courses are centered around the USAJFKSWCS which teaches Army Special Operations doctrine to its soldiers. The Advanced Noncommissioned Officers Course (ANCOC), and the Special Forces Qualification Course are examples of courses that teach Special Forces doctrine.

Unit training centers on requirements needed to train a unit as a whole, for example the National Training Center. There are various types of training events that occur under unit training. For example, Joint Chiefs of Staff (JCS) exercises are joint level exercises that develop Special Operations interoperability with the other Services' forces. Joint Combined Exercise Training expands this training with other foreign Special and/or Conventional forces. The Joint Readiness Training Center (JRTC) puts Special Operations units into a tactical scenario and tests their mission skills in a realistic environment. Deployments for Training (DFT) and Mobile Training Teams (MTT) are usually centered around training with or training of a foreign country's forces. Their training tasks are usually more specific and the training duration is usually longer. In addition, demonstrations are usually utilized to emphasize a capability the Special Operations can perform.

Individual training revolves around the requirements needed to train one individual, such as developing those skills that an individual needs in order to accomplish his mission or to add value to the unit's mission accomplishment. An example of individual training is airborne school. Military Occupation Specialty (MOS) training centers on training tasks that will prepare the soldier for his primary job skill.

Skill training are those training tasks that enhance or complement the soldier's primary job tasks.

Leader training centers around the skills, requirements, and courses designed to develop the soldier into a leader, such as the Primary Leadership Development Course (PLDC).

Figure 3-7depicts the *Training* class of the Soldier System.

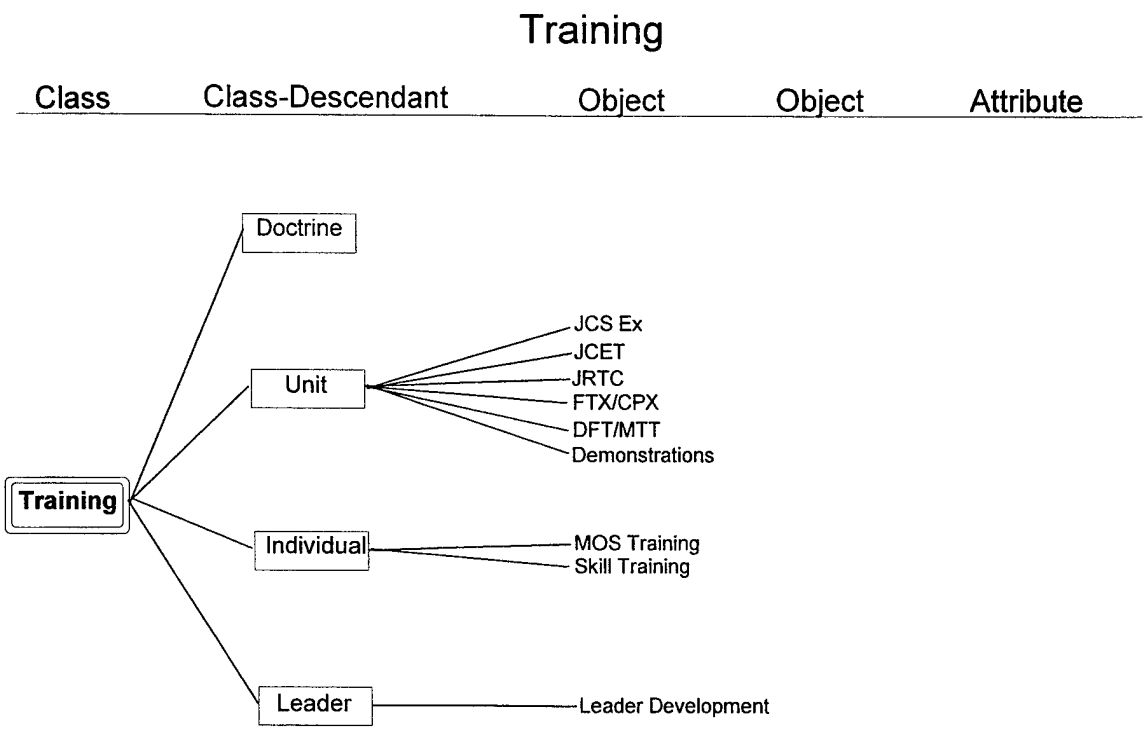

Figure 3-7. Training

N. ORGANIZATION

The Soldier System looks at the organization in order to provide the structure around which it can operate. There are primarily two organizations that could affect the soldier. USASOC has a major effect on the soldier in the Special Forces

Community. USASOC has many different types of units under it which performs various mission profiles. USAJFKSWCS is the structure around which training tasks are conducted. United States Army Civil Affairs and Psychological Operations Command (USACAPOC) has the responsibility of supervising Civil Affairs and Psychological operations. Special Forces Command is responsible for coordinating and supporting Special Forces units. The Ranger Regiment is responsible for conducting short duration, quick response, high intensity direct action missions. The Special Operations Aviation Regiment is responsible for providing aviation transport and attack support to Special Operations Forces. The Special Operations Support Command is responsible for providing tailored support from conventional support assets in various theaters of operations.

BASOPS support provides installation support services to the soldier, his unit and to his family through Memorandums of Understandings (MOU) and Agreements (MOA). Post installations are usually organized by function such as the Directorate of Resource Management, Directorate of Contracting, or the Directorate of Logistics. Figure 3-8 depicts the breakout for *Organization.*

O. LOGISTICS

Logistics is the third class of the ARSOF Soldier System. It centers around the sustainment of the soldier system and is defined as the means necessary to ensure that the system operates at its operational tempo and is able to accomplish its mission. Sustainment is the "staying power" of the ARSOF soldier, usually measured in number of days of capability to sustain combat.

Logistics deals with the structure that supplies and supports the soldier and its deliverables. This structure is narrower in its focus around the soldier than the overall logistics infrastructure. Class-descendant Engineer/Facilities deals with the establishment of shelter for the soldier and his family in work and living environments.

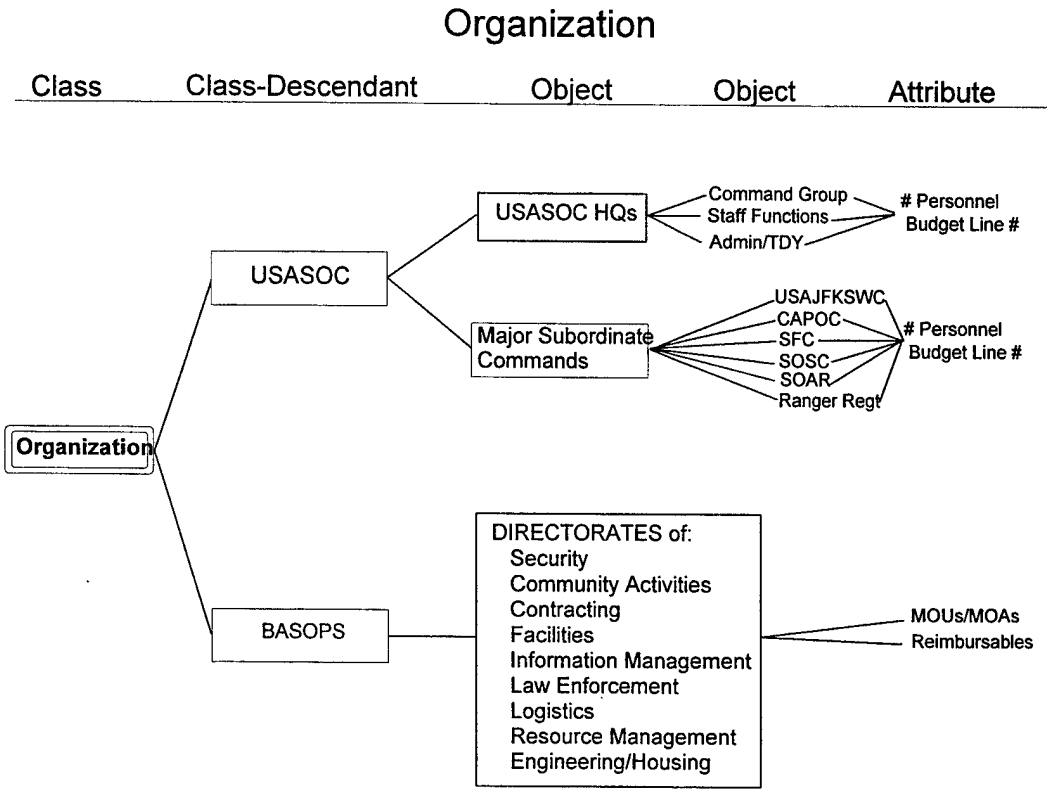

Figure 3-8. Organization

Housing is concerned with the living quarters of the soldier and his family; Military Construction (MILCON) is concerned about the construction of facilities which will support the soldier and his organization in the work environment. Minor construction concentrates on smaller localized projects that support the soldier. Real Property Maintenance Activities (RPMA) includes the operation of utilities, maintenance of real property, minor construction, fire fighting, and real estate services. These normally have a larger scope, but if tied to supporting the soldier, then they are relevant to the Soldier System.

The class-descendant Distribution supports distribution of supplies and materiel for the Soldier System. The class-descendant Fix repairs Soldier System

equipment. This class-descendant is defined as an item that is retained or restored to specific conditions using prescribed procedures and resources, at either the operator, Direct Support (DS), or depot levels. These are the measures taken to get the non-mission capable soldier system back on line and fully mission capable.

The class-descendant Arm provides ammunition to the soldier system, whereas the class-descendant Fuel providing life essential products to the soldier which are food, water, and air. Food helps the soldier maintain his energy to perform his duties and missions both in garrison and in the field. Its packaging is critical in the field environment because it must have sufficient nutrients for the soldier, but must also be small, fresh, and light enough to be carried in sufficient quantities. Water is essential to keep the soldier hydrated in order to perform his mission. Water purification devices may be critical in areas of brackish or doubtful quality water and especially critical for the soldier who is a combat diver, High Altitude Low Opening (HALO) parachutist, or soldier going into an area of doubtful air quality (NBC environment). Fuel is the power source provided to the equipment itself, such as miniature battery powered electricity and miniature gas fueled generators. Other sources of fuel are POL items such as white alcohol for fuel stoves, break free, and lubricant for weapons. Figure 3-9 depicts the Logistics class.

P. SERVICES

The class *Services* supports the soldier's welfare. The class-descendant Professional Career enhances a soldier's career through education, promotions, awards, and other administrative matters that help keep the soldier combat effective. Administrative systems that are tied to the soldier include the handling of routine matters which help to retain him in the short and long term. One object is Career Management Field 18 which centers around the soldier's efficiency reports, promotion boards, and assignments. The promotion system determines the right mix

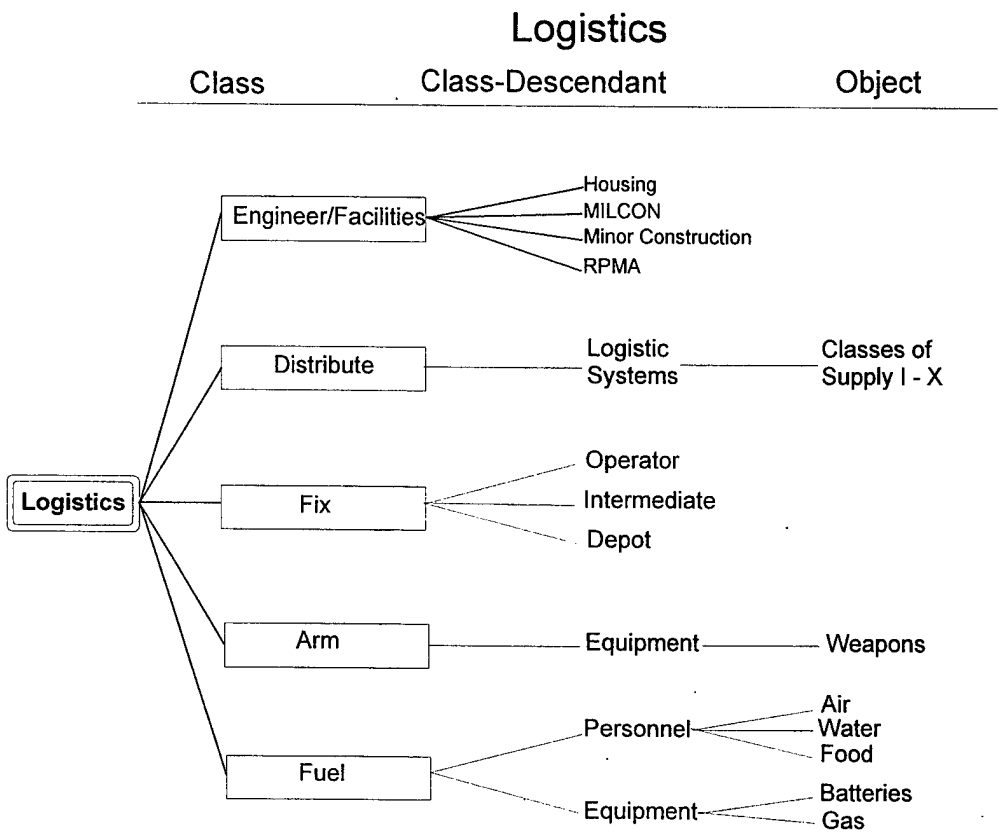

Figure 3-9. Logistics

of soldiers and promotes the most highly qualified to higher positions of responsibility. The awards system recognizes soldiers who accomplished tasks deserving merit and praise. The educational system, such as the Army Continuing Education System, helps the soldier to improve his education level.

The class-descendant Soldier Family Programs could consist of activities which are outside of the MWR control, but which provide a service to the soldier and his family. Religious and Social Services Counseling help the soldier who has particular needs. Counseling deals with the emotional and spiritual aspects of maintaining the soldier, for example Alcohol and Drug Abuse counseling. This component can be handled by the first line supervisor, peer, mentor, Chaplain, or

family counselor. Army Emergency Relief provides emergency benefits to soldiers when certain crises develop and the soldier is short of funds. This class-descendant also includes the unit family support groups and the chain of concern established to take care of the soldier and his family's needs.

The class-descendant Medical Care heals and maintains the good health of a soldier and can be further sub-divided into inpatient and outpatient care. Medical care also provides health care in a tactical and garrison environment. Physicals, specialized care, emergency medical treatment, the sick call system, surgery, physical therapy, and recovery are all example of possible objects under medical care.

The class-descendant Financial Assistance is the component that deals with the soldier's financial problems. This can be handled by the first line supervisor, or Army financial advisor as well as Army Emergency Relief. Another object is Financial Services such as the Defense Finance and Accounting System, which fits into the soldier system by ensuring that he is adequately paid. This includes special pay, hazardous duty pay, and other compensation examples.

The class-descendent Legal Assistance helps the soldier with all aspects of the legal system, such as notary public, legal counseling, last will and testaments, power of attorney, and representation in a court martial.

The class-descendant, Morale Welfare, and Recreation (MWR), keeps the soldier in a positive state of mind and provides primarily non-work services. These are activities that are usually not covered in the above category and revolve around recreational activities to the soldier and his family. Examples are discount tickets, trips, USO facilities, and other non-profit centers as well as outdoor recreation items for checkout, trips to various sites for the soldier and his family, and dining services for eating outside of the home but on post. In addition, this class-descendant also includes services such as the gas station, post exchange, and the commissary.

Figure 3-10 depicts the *Services* class utilized by the soldier and his family: [Ref. 24:p. 14-15]

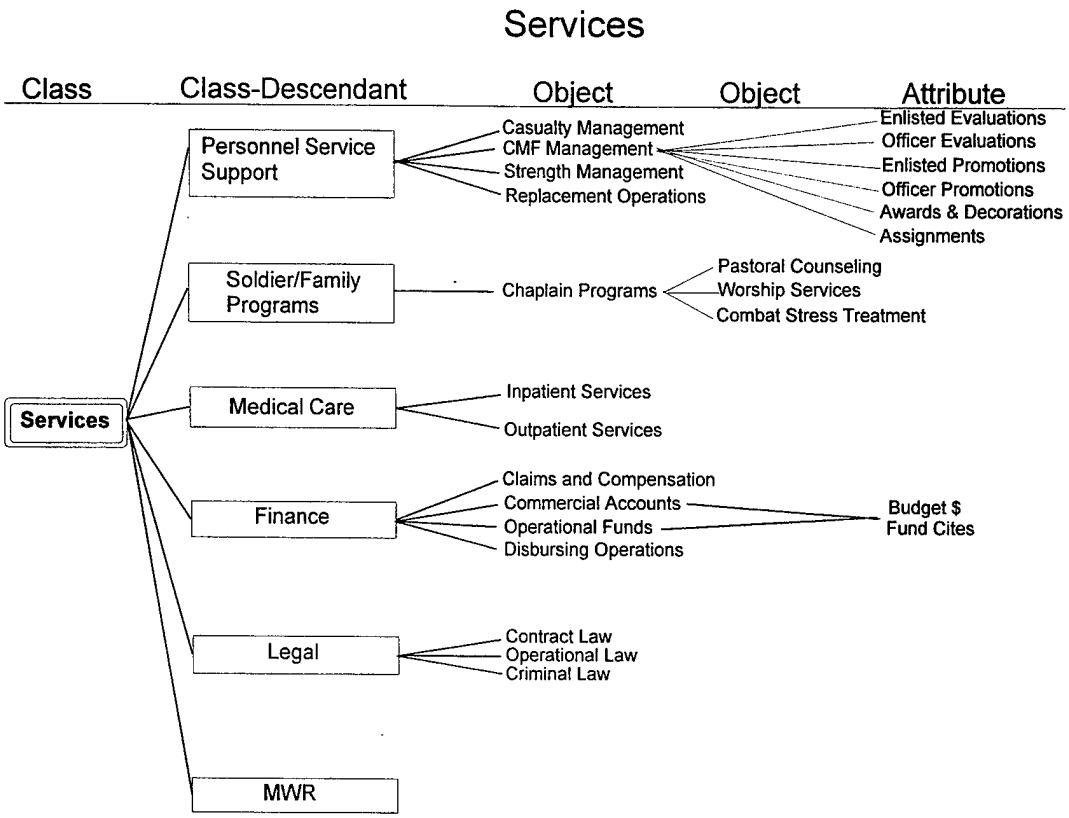

Figure 3-10. Services

Q. FAMILY

The *Family* class identifies those aspects that affect the soldier and his family. A spouse is female because this ARSOF Soldier System primarily focuses on the combat arms soldier who is male. If there are changes in future policy concerning women in Special Operations combat roles, this system can easily adjust to this because of the use of object-orientation. The Family class is further sub-divided into two descendant classes of spouse and children. Attributes that can be looked at are

height, weight, age, color of hair and eyes, years married, education level, working or not working. Children can be further sub-divided into boys and girls. Figure 3-11 depicts the *Family* class.

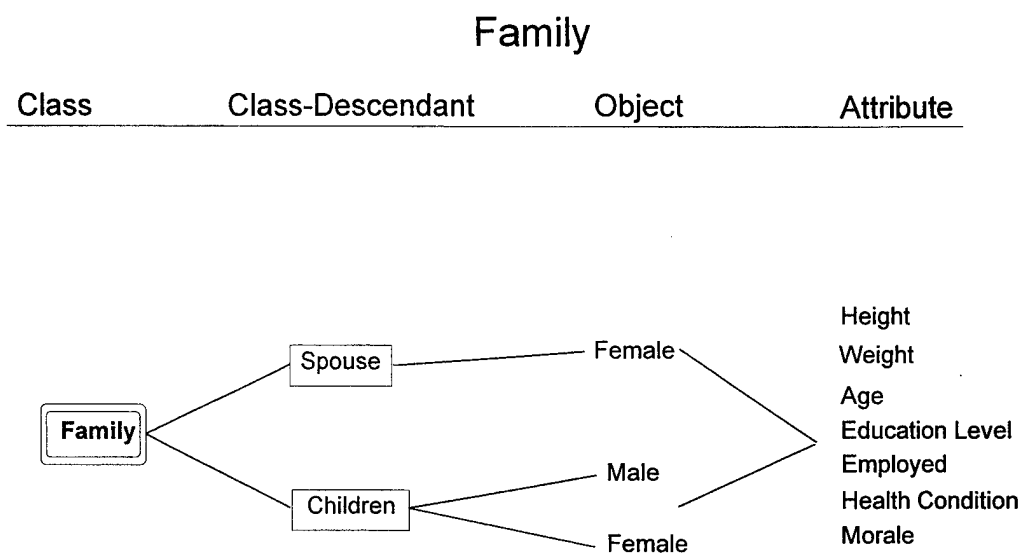

Figure 3-11. Family

R. SOLDIER

The *Soldier* Class is sub-divided into three class-descendants. The first class-descendant is the past experience of events which have shaped the soldier and added valuable skills to the Special Forces soldier over other soldiers. For example, a soldier who has hunted as a child or young man may have an advantage over a soldier who grew up in an urban environment. Soldiers who are avid skiers or swimmers may bring skills which will help when they go to a mountain detachment or a SCUBA detachment. Experience is past activities the soldier has retained in memory. It is formally defined as the active participation in events or activities, leading to the

accumulation of knowledge or skill. The soldier may also bring to Army Special Operations useful experience from prior service in other branches and fields as well as experience from the civilian sector which may have a direct or indirect impact on what he is doing in the military and Army Special Operations. Experience indicates how much new training or retraining is required to get the soldier up to the standard expected of him.

The second class-descendent Inherent Capabilities is skills that a soldier is born with or has naturally developed. For example, some soldiers are smarter than others; others are very skilled at hands-on types of tasks. Some are skilled at deductive reasoning or solving complex theoretical types of problems and others are naturally bigger. Some soldiers develop easier as runners and others as weight lifters. These advantages can be brought out through aptitude, personality tests, and physical tests.

The object Inherent Physical Capabilities is the physical traits that make up each individual soldier. There are traits or standards that USASOC feels should compose a generic ARSOF soldier. Traits may also be subdivided into standards for certain types of physical characteristics needed for special mission profiles. For example, a male Special Forces soldier who doesn't pass the requirements for a HALO parachutist physical would not be able to participate in HALO training or operations even though he would be able to perform other Special Operations mission roles. Many of these standards are established by the Special Forces physical and are further subdivided by the SCUBA and Special Mission Unit (SMU) physicals.

The object Inherent Mental Capabilities is the traits that make up the aptitude of the ARSOF soldier. Certain substandard levels of intelligence are screened out with the standardized tests and interviews conducted at Special Forces Assessment and Selection Course. IQ tests are used to screen for intelligent soldiers or soldiers

who have the aptitude to learn new and complex tasks. Special Forces then sets a minimum level for intelligence which selects soldiers most likely learn the knowledge required to be successful.

The third class-descendant Morale and Attitude examines the soldier's mental state at the time he is involved with Special Operations. If a soldier is not happy with his job, family or other issues, it will have an affect on his job performance. The difficulty in this category is trying to quantify the aspect of morale or attitude. Standard psychological testing, counseling, and attitude surveys can shed some light as to how an individual or a unit as a whole may stand mentally or in attitude.

Morale and attitude are the behavioral state of the soldier. Morale is defined as the spirit of an individual or group, as shown in willingness to perform assigned tasks. Attitude is defined as a position of the body or manner of carrying oneself, indicative of a mood or condition. If a soldier does not have high morale, then the likelihood of mission accomplishment will naturally tend to drop. Many factors affect morale and attitude. In addition, morale and attitude are often conditioned from the unique situation or position of the soldier. It is the job of the leadership to identify what is causing the attitude and what they can do to relieve it. Another aspect is the composition of the soldier's ethical background which needs to be firmly established. A further aspect of morale and attitude is the psychological makeup of the ARSOF soldier. Personnel with dangerous and or debilitating psychological problems should be identified and removed immediately from the units involved. Psychological tests and monitoring by the chain-of-command will help to identify those that are mentally unstable or have a poor attitude. Figure 3-12 depicts the *Soldier* class.

S. LEADERS

The *Leaders* class includes those individuals that have an influence on the soldier. There are two types of leaders, formal and informal. The formal leader is the

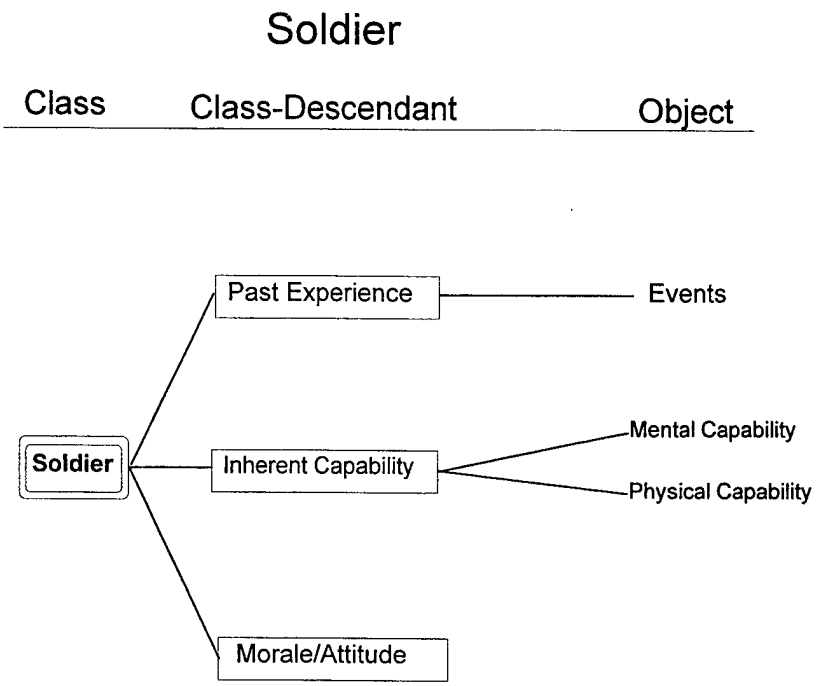

Figure 3-12. Soldier

person designated by the Army to fill a leadership position. Depending on the formal leader's strength of influence, he may or may not have a great deal of influence on the soldier though he usually does have a baseline of influence. The informal leader does not have formal authority, but does have influence of character or personality that has an affect on the soldier. The informal leader cannot be discounted in influencing the positive or negative behavior of the soldier. Figure 3-13 depicts the *Leaders* class.

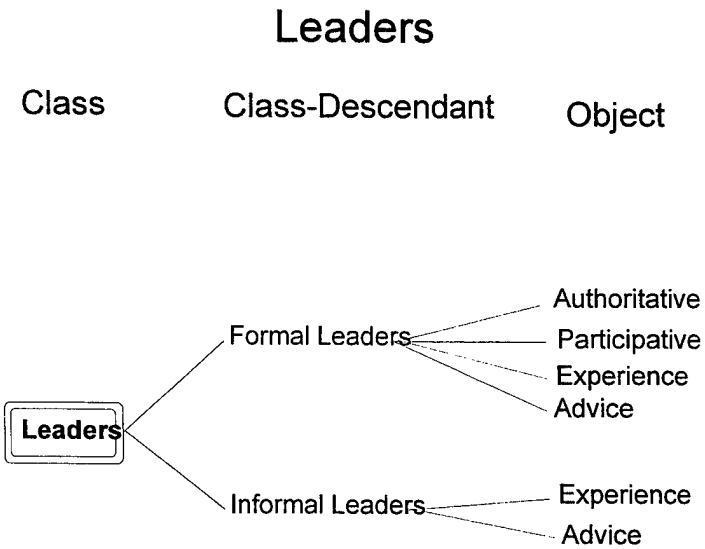

Figure 3-13. Leaders

T. MOBILITY

The *Mobility* class assists a soldier's movement to his mission objective and safe return. Walking, running, and swimming are three functions of mobility that a soldier can do unassisted. The mobility systems are sub-divided into three class-descendants and then further sub-divided. Air deals with the soldier transported by air. It may also deal in the future with how the individual soldier may fly, for example a jetpack, and will include hang gliders, powered parasails and other man portable flight systems. Airland systems deal with aircraft that help deliver soldiers and their equipment, such as C-130s and helicopters. These systems are very large and complicated in themselves, and should not be considered as part of the Soldier system, but instead as complementary. The key to interfacing with these systems is to ensure that the soldier and his equipment are included when the design concepts are developed for these aircraft. The mobility system also looks at more personalized types of aircraft that are specialized towards the individual soldier, such as ultralight aircraft. Air Delivery equipment concerns safely delivering the soldier to the ground from an aircraft with parachutes, fast-ropes, and rappel systems. HALO parachutes are a specialized variant of parachutes for the Special Operations soldier. Recovery equipment such as the Fulton Recovery System, Special Patrol Infiltration/Exfiltration System (SPIES), and small rescue ladders are equipment used to extract a soldier.

Land is the second component of mobility systems. It comprises basic movements such as walking and running as well as vehicles, motorcycles, bicycles; all terrain cycles (ATC), and other tactical wheeled vehicles. Most vehicles are not included as part of the soldier system because they are larger systems and considered separate from the soldier. This helps to keep the context of the problem domain focused on the soldier. Small systems such as bicycles and motorcycles are bulky and man-portable, but may be considered for the soldier system.

Sea is the third component for the mobility systems. This comprises swimming, mini-subs, kayaks, sailing boats, and power craft which include systems that move above and below the water. Systems used above water are Klepper kayaks, folding kayaks, inflatables, patrol craft, and ships. [Ref. 37:p. 28] Systems used underwater include SCUBA, small submersibles, and submarines. Sea systems are also constrained by the context of the problem domain. Some submersibles, patrol craft, and ships would be too large and would also be considered complementary to the soldier system. Figure 3-14 depicts the *Mobility* class.

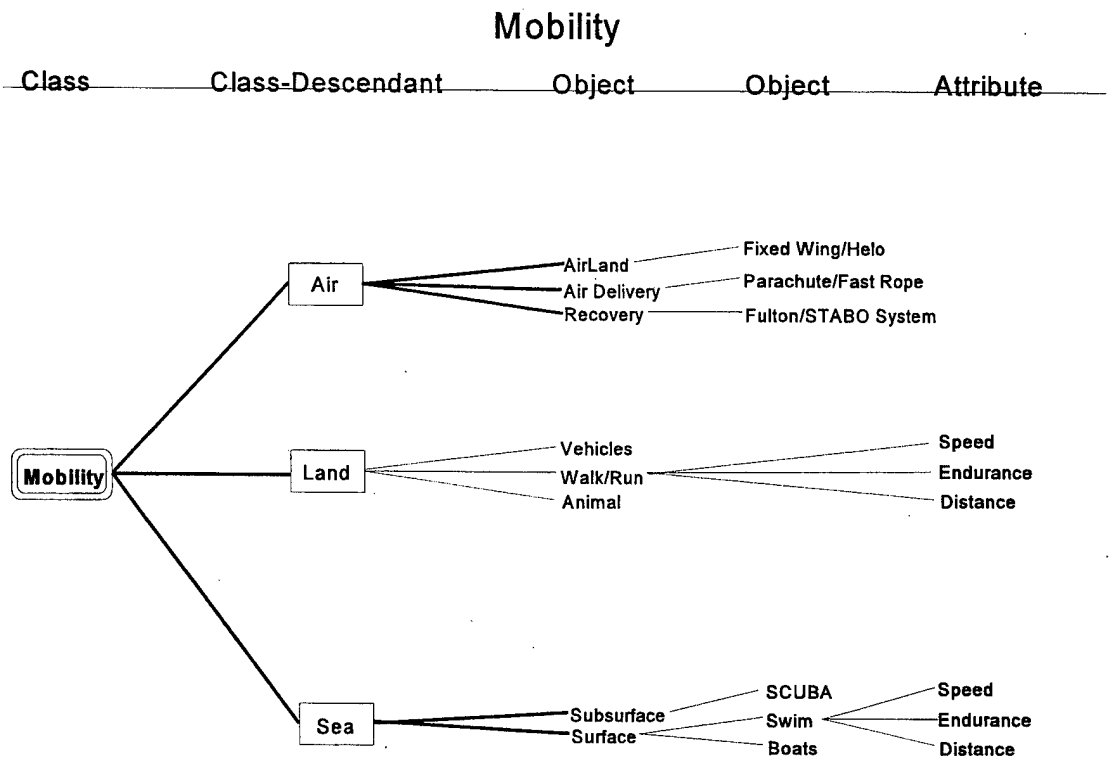

Figure 3-14. Mobility

U. SEP/SIPE/GEN II/21st CLW

The Soldier System encompasses the equipment and weapon systems of the Soldier Enhancement Program, Soldier Integrated Protective Ensemble, GEN II

Warrior System, and the 21st Century Land Warrior. This class is further subdivided into four class-descendants: Weapons, C4I, Protection, and Optics.

The Weapons class-descendent is subdivided into five objects. This is the class-descendant that is responsible for delivering the force necessary to defeat the enemy or render it neutral. Weapons included in this category must be man-portable by the soldier, such as point weapons which can be aimed and fired at a distinct location. Some examples are hand-to-hand combatives, knives, pistols, rifles, sniper rifles, Rocket Propelled Grenades (RPG), Ranger Anti-Armor Weapon System (RAAWS), and Light Anti-tank Weapon System (LAWS). These weapons can also range into exotic weapons such as tasers, lasers, and microwaves.

The second object is area weapons which are the delivered ordnance aimed at an area and not necessarily a specific target. Area weapons have ammunition fragments that cover a larger area rather than a specific point. Examples of area weapons are shotguns, hand grenades, MK-19 grenade launcher, M-60 Machine Gun, and the M249 Squad Automatic Weapon. Other weapons in this category are CS grenades and incompacitating sound waves.

The third object is indirect weapons which are aimed at targets generally not in the line of sight. Examples of these weapons are the 60mm lightweight company mortar and the M-203 grenade launcher.

The fourth object is demolitions. Demolitions are substances which are lightweight but have great explosive power. Some examples are dynamite, Trinitrotoluene (TNT), C-4, Semtex, detonation cord, time fuse, and blasting caps.

The fifth object encompasses mines and booby traps. Mines are weapons which are placed in hidden locations and are tripped or are set off at a designated time. Examples are anti-personnel, anti-tank, pursuit denial munitions, Selective Lightweight Attack Munitions (SLAM), and Wide Area Mines (WAM). These

weapons are designed for light weight portability and for anti-personnel and anti-armor effects. [Ref. 37:p. 26]

The second class-descendant Command, Control, Communication, Computers, and Intelligence (C4I), encompasses a wide ranging class covering the areas that give the soldier greater situational awareness. C4I in this system is responsible for the Command and Control, Communication, Intelligence, Information Management, and Target Acquisition components of the system. C4I is defined as the combined capacity to deliver orders to military units; to continually monitor and control their presence, movements, and status; to be well-informed of enemy movements and intentions; and to be able to relay and receive messages reliably, quickly, and secretly. Command and control are the systems that cover strategic, operational, and tactical areas of importance. Communications are those pieces of equipment that allow the soldier to interface, at the strategic, operational, and tactical level.

The object Command and Control is the component that is responsible for orders issued and controlled. These are the verbal and written commands which direct the soldier to accomplish his mission, and also keep the soldier within certain bounds to prevent any legal or other type of problems. Examples are operations orders, Fragmentary Orders (FRAGOS), Permanent Change of Station (PCS), Temporary Duty (TDY), and work orders. These are directive in nature and usually narrow in scope. Examples of regulations are Army Regulation (AR) 670-5, or USASOC Regulation 350-1. Regulations are usually wide ranging and of a consistent nature in order to last over the long run.

The object Communications encompasses equipment such as radios, loud-speakers, television screens for remote meetings, and computer monitors on network systems. Communications can be one way or two way depending on the desire of the

soldier. Signaling is an element of communications in which the soldier can make his presence known or make a statement of some type. Examples of signaling within this component are strobe markers, chem lights, sound, panel markers, mirrors, smoke grenades, or Identification, Friend or Foe (IFF) devices.

The object Intelligence provides analyzed information that the soldier will utilize from the tactical, strategic, and operational levels as well as the intelligence that he will send forward to his superiors.

The object Information Management refers to the computers and the networks used by the soldier and being presently developed on the 21st CLW system. Computers and information management compile all the information that is being secured by the soldier and also the information that the soldier is collecting when in a tactical environment.

The third class-descendant is Optics, which are systems used to improve the vision and target acquisition of the soldier. Some examples of this are binoculars, night vision devices, and thermal imagery. Target acquisition is the object by which the soldier can lock his sight, weapon, or other object onto a target. Some examples of these are the laser range finder, AN-PEQ1A Laser Marker, and weapon laser aimpoint. [Ref. 37:p. 28] Vision Devices are objects used to gain better visual reception. Examples are night vision devices, binoculars, and a sniper scope.

The fourth class-descendant is Protection, which are those pieces of equipment which will enable the soldier to survive in his environment or on the battlefield. Protection is defined as the capability of a system to avoid or withstand a natural or man-made hostile environment without suffering an abortive impairment of its ability to accomplish its designated mission. The components of protection work from the skin in to skin out.

The object Medical Protection is the skin-in protection of the soldier against medical threats. Examples of these components are immunizations against common diseases in which the soldier may operate. Medication are also another way to protect the soldier. For example, malaria prophylaxis is supposedly able to help protect the soldier in areas that are endemic to malaria. Insect repellant also helps to repel disease bearing insects away from the soldier.

The object Environmental Protection describes protecting the soldier from the harshness of the environment with clothing, shelter, and temperature control. Clothing is the immediate protection to the soldier that is outside of the skin and is portable. Its protection is mainly against environmental effects. Examples of clothing are Battle Dress Uniforms (BDU), Goretex, cold weather gear, SCUBA gear, Nomex flight suits. Cold weather clothing helps to keep the body warm in winter or arctic-type terrain. Hot weather clothing protects the body and keeps it cool in jungle or desert type environments. Shelter also provides protection, but it is not as portable as clothing. Examples of shelter are tents, barracks, Force Provider, on-post housing, and off-post housing.

The object Ballistic/Laser protection keeps the body protected from laser, shrapnel, and small caliber rounds. This component is composed of materials which protect the soldier from bullets, fragmentation, and laser beams. Examples of this component are body armor, helmets, laser glasses, and hi-impact glasses. Examples of ballistic/laser protection are Ranger body armor, Kevlar helmet, and gargoyle protective glasses.

The object Signature Management is primarily responsible for preventing the soldier from being detected. Examples of this are camouflage paint, netting, and uniforms which will help to reduce the soldier's chance of discovery by sight. Other

types of coatings are being researched that can reduce the soldiers chance of detection by infrared, thermal, or other means.

The object Nuclear, Biological and Chemical (NBC) protection, is the protection from nuclear, chemical, and biological effects. Examples of these are Mission Oriented Protective Posture (MOPP) suits with protective masks and biological suits protecting against chemical and biological threats. Figure 3-15 depicts current conventional Soldier Systems.

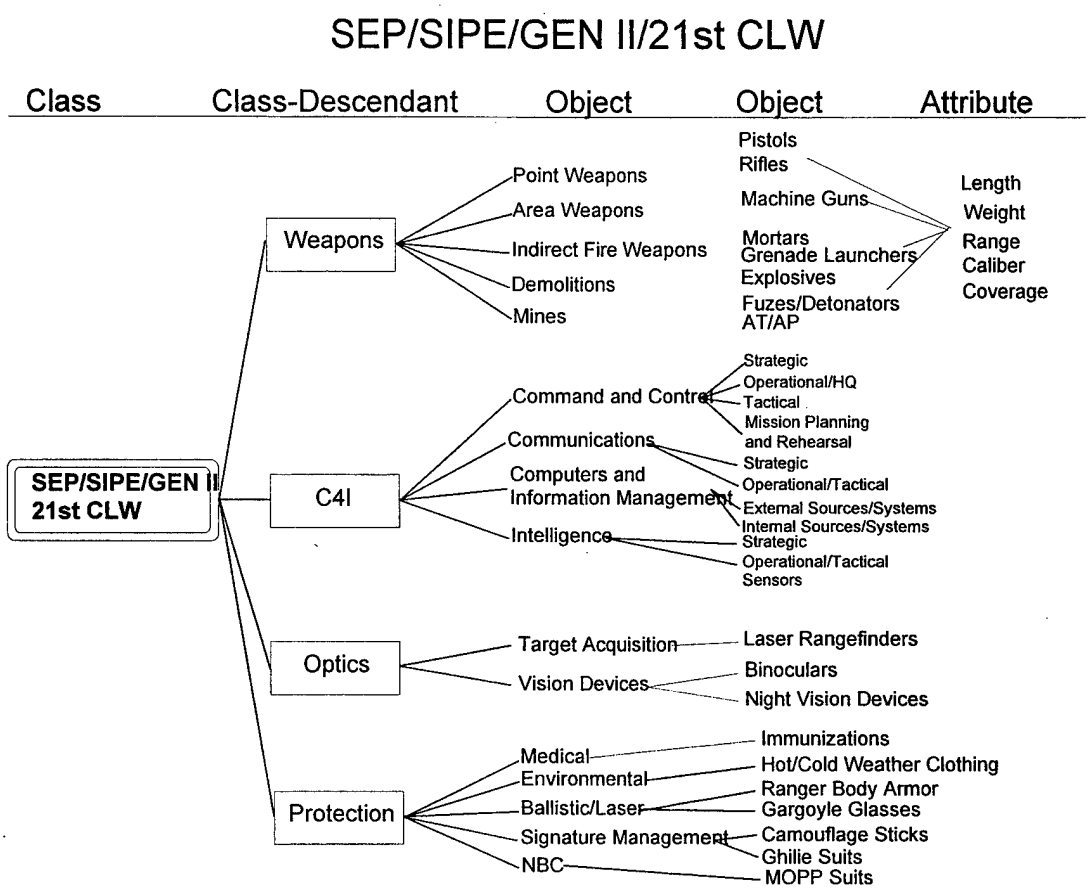

Figure 3-15. Conventional Soldier Systems

V. SUMMARY

The ARSOF Soldier System utilizes aspects of the Coad/Yourdon and Ivar Jacobson models of object-oriented structures to depict how a Special Operations Soldier system architecture may be designed. This use of object-oriented modeling provides the flexibility to design and construct a Soldier System which actually reflects what the soldier utilizes or is affected by. Tangible and intangible objects would also be linked together within the same model. Object-oriented structures are also flexible enough to adapt to changes without a great amount of structural rewriting or reorganizing.

This chapter showed how the soldier can be broken down into a system architecture of problem domains, classes, objects, and attributes. This architecture shows a general view of the soldier at the problem domain level and specific detail of the soldier at the attribute level.

IV. IMPLICATIONS AND CONSEQUENCES

A. IMPLICATIONS

There are two main implications from this proposed model of the Soldier System presented in this thesis. First, the ARSOF Soldier System introduces a new way of looking at the soldier. Previous methods were done in isolation. Materiel programs focused on the equipment aspect of the soldier in the past. As a result, the soldier perspective focused on the soldier but did not integrate itself with the other programs. The organizations will now focus on proper alignment and support of the soldier. Previously, soldiers were considered just another piece that functioned in the overall machine. But the soldier is the machine, and everything else is added to improve his capabilities. The Soldier System has at times been examined from the personnel aspect, or training, equipment, or operational aspect. Instead, the soldier should be looked at from a system aspect. All of these aspects are components of the system. The soldier has not been treated as the sophisticated integrated weapon system that he is.

The second implication is that planning be focused on the soldier instead of all the separate programs that support or affect the soldier in one way or another. This gives impetus for the groups to work together to reach commonality and standard ways on how the soldier should be integrated. This soldier system, with its model based on object-orientation, allows flexibility for USASOC to make changes by increments instead of wholesale changes to the system overall. This also gives the planner the freedom to integrate such systems as "quality of life" and materiel systems which previously were not involved together in the improvement of the soldier. Finally, object-orientation allows for the planner to include such diverse systems underneath the umbrella of one program or soldier system.

B. CONSEQUENCES

There are four consequences that may result from the use of this model for the soldier. First is that the soldier will be perceived as a system. Second, there will be more consideration of qualitative aspects for inclusion in the Soldier System. Third, some functions may not be included while new functions will be added to the system. Fourth, programs will need to be reviewed by USASOC to determine what it can control or influence concerning the Soldier System.

1. Perceived as a System

The first consequence is that the soldier will be perceived as a system which is a great leap in thinking. The GEN II Soldier System and the 21st Century Land Warrior program have done a great deal towards this new perception. Their only drawback is that the soldier is considered from the materiel aspect, and changes needed in soldier programs and organizational systems are virtually ignored. The Land Warrior program will ultimately improve all five capability areas for the soldier: command and control, lethality, survivability, mobility, and sustainment. Force XXI initiatives will impact the areas of doctrine, training, leadership development, organization, materiel, and soldier (DTLOMS). The lessons learned from the two war fighting experiments, Warrior Focus and Task Force XXI, will be incorporated via design decisions into the Consolidated Land Warrior system. This is a big step in the integration of these systems into a central soldier system. The integration of structure with materiel is occurring, but not in conjunction with the overall soldier system. The main issue is to integrate the soldier and quality of life issues with the former two; then the soldier system will be complete. There is still a great deal of work left to decide what should be included in a soldier system, but the challenge now is to get leaders to expand their idea of what a soldier system encompasses in order to get a true picture of a soldier system's limitations, capabilities, and life cycle costs.

The systems approach will allow for the soldier system to compete for resources against other systems such as the tanks, aircraft, and ship systems. It will also help bring a more rational approach to how programs, organizations, and equipment are planned and developed around the soldier.

The Special Operations soldier has its own unique characteristics and needs in comparison to other soldiers in the other branches of the Army and sister Services. Special Operations has concentrated on the sense of urgency in its operations and in its reliance on the ability of its soldiers. It is not heavy in equipment, organization, or the number of personnel. This can be a disadvantage during budget planning when the soldier, with his small equipment purchases, has to compete against large tangible weapon systems. Though 21st CLW is working on solving this aspect, the soldier needs a systematic and comprehensive approach in order to survive in future operations.

2. Quality of Life

The second aspect concerns qualitative aspects considered for the soldier system. The advantage of object-orientation is the connection between quantitative and qualitative aspects of the soldier within one system. Quality of life issues have gained a greater amount of attention during the past two years. The factors for recruiting and retaining soldiers have been directly tied to the beneficial aspects provided to the soldier and his family. Services such as housing, recreation, counseling services, commissary, and PX services, have had their affect on the morale of the individual soldier and his family, and these are crucial if the Army wants to retain quality soldiers after spending a great sum of money on training, equipping, and caring for that soldier.

Secretary of Defense William J. Perry said the following concerning quality of life during his annual report to the Congress:

> Readiness is associated most closely with the morale and esprit de corps of U.S. soldiers, sailors, airmen, and Marines. These intangibles are maintained by ensuring the best quality of life for people in uniform and their families. Quality of life falls into three general categories: standard of living; ...demands made on personnel, especially time away from family; and other ways people are treated while in the Service. [Ref. 18:p. 1]

The effort to attract, train, promote, and retain quality soldiers is a crucial link in ensuring that the gains from technology for soldier equipment is utilized by a well-qualified soldier. In the report, the Secretary of Defense reiterates the "iron logic" that connects the Armed Forces' readiness and their quality of life. [Ref. 18:p. 1] This is backed up by the collective evidence of senior members of the Defense Department and by surveyed evidence. In a survey conducted in 1994 by the U.S. Army Research Institute for the Behavioral and Social Sciences, quality of life, pay, and housing topped a list of 53 reasons Army soldiers gave for leaving the service. [Ref. 18:p. 1]

Re-enlistments from the Services overall are keeping the Armed Forces up to strength, but first-time enlistments have declined according to surveys on the attraction for young people to enlist. The Task Force also expressed its concern about maintaining the current retention rate given what they have heard from the numerous service "town meetings." [Ref. 18:p. 1]

The Task Force is convinced that service people need relief from inadequate housing, unsustainable personnel tempo, and inadequate community and family support for the good of the All Volunteer Force System. They also agree that putting off action may increase the eventual costs of a recovery. Deputy Defense Secretary John White said that, "Quality of life is like inflation-once you get behind it, it costs an enormous amount to get back on track; and it already carries some of our highest up-front costs." [Ref. 18:p. 1]

There were three keys elements to quality of life cited by the Task Force in their report: housing, pace of life, and community and family services. The report stated that despite the amount of resources expended on military housing, much of it failed to meet the Defense Department's intended goals which were to provide excellent housing facilities and services to all eligible military members, their families, and eligible civilians. The task force admits that correcting the deficiencies will be expensive, but further delay will only exacerbate the problem and may cost the Army talented people who will choose to leave the service. [Ref. 18:p. 3]

The Task Force also noted that most installations have some fully adequate family and bachelor housing, but there are numerous instances of housing that is too small, poorly maintained, and inconveniently located. Many of the houses contained substandard plumbing, heating, cooling, and electrical systems that made daily activities a trial and lowered morale. [Ref. 18:p. 3]

The second key is personnel tempo. Secretary of Defense William J. Perry said that,

> ...the drawdown has caused many Service members to question their long-term commitment and the prospect of a full career. The turbulence of consolidations and base closures has disrupted assignments and family life...and a high tempo has put an extra strain on selected units. [Ref. 18:p. 7]

The Task Force also noted that the consequences of excessive personnel tempo impair readiness and influence every other aspect of quality of life. The U.S. Army Research Institute for Behavioral and Social Sciences provided statistical evidence that there is a direct correlation between family separations, adverse retention rates, and spousal support for an Army lifestyle. [Ref. 18:p. 7]

The 1995 Annual Defense Report to the President and Congress stated:

> Since frequency and length of deployments can affect a family's stability, finances, and other aspects of living, the Department must commit to sponsoring programs for families who are affected by increased PERSTEMPO...the goal is to find a balance between mission and training requirements that draw Service members away from home and their need to spend valuable time with their families. [Ref. 18:p. 66]

The task force made recommendations to balance service and joint training within reasonable time frames. It also recommended that the definition for counting deployed time be: 1 day away = 1 day away. This is because the Services have different methods for accounting for deployed time. For example, the Navy credits a unit for deployed time when it exceeds 56 days. The Marines give credit for deployment after 10 days. Further, it recommended increased use and integration of the reserve forces to relieve the pressures of active duty deployments and operational tempo. They also recommended increasing utilization of contract support services to relieve personnel tempo. Support contractors have been successfully used in this model for operations after Desert Storm and more recently in Somalia, Rwanda, and Haiti. [Ref. 18:p. 7]

The third key is community and family services. Chairman of the Joint Chiefs of Staff, General John M. Shalikashvili, said in May 1995 that "military people stay in the service because they like being part of something special. They won't stay long, however, if families aren't treated well." [Ref. 18:p. 11] These services for the family and the soldier are key to their morale, performance on the job, and future retention.

The All Volunteer Force has changed the demographics of the military community since its inception in 1974. The percentage of married personnel has increased by more than 8 percent. Sixty-five percent of spouses are employed.

Single parents, 5.7 % of the military population, have become much more common. There has also been a constant increase in the number of dependent preschool-age children and there are about one million dependent children under the age of twelve. Military recruits are also better educated than in the past and cite educational benefits and job training as their top two reasons for enlistment. [Ref. 18:p. 11]

These changes in demographics have overwhelmed the Community and Family Service programs and have driven down quality responsive service to everyone. Nearly 144,000 more spaces for child care are needed at present. More than $34 million in bad checks are being cashed at Army and Air Force PXs each year, and bad credit is usually the primary reason for denying or revoking a security clearance. Furthermore, more than 28,000 cases of military family violence incidences were substantiated in 1994. [Ref. 18:p. 11]

The task force focused on a number of areas of community and family services which have a great affect on the soldier and his family. The first recommendation was to lift full-time equivalency rules that restrict civilian child care hires in order to eliminate staff shortfalls and provide a higher quality service to the families' children. The second recommendation from the task force was to reinforce relocation assistance, personal financial management, counseling, and other services. The task force also recommended improvements to the automated relocation services information system, financial management counseling, and family advocacy programs which educate families to provide improved support. Further, the task force recommended exempting military spouses from civilian full-time equivalency rules to help them find more compatible work. [Ref. 18:p. 12]

The task force made recommendations for improving educational opportunities. This is crucial to the soldier system since opportunities for training and education are the most frequently cited reasons for military enlistment. The task force

made a number of recommendations because they believed that education and training prepare individuals to execute assigned missions effectively. The first recommendation was that tuition reimbursements rates should be standardized among the Services. They also encouraged the use of Distance Learning educational programs, the awarding of associate degrees that give credit for military training, and the Federal Impact Aid program which reimbursed public school districts supporting large numbers of military school children. [Ref. 18:p. 13]

The task force also looked at the variety, quality, and availability of Morale, Welfare, Recreation (MWR) programs and fitness centers. They noted that these were understaffed, under-equipped, and inconveniently located. The task force also recommended more funding for the construction of facilities and Youth Services. Youth Services have broadened their scope to provide counseling and education for at-risk youth and prevent youth and gang violence. Parents expressed their concern about more employment opportunities for youths in the summer. The task force suggested giving the installation commanders the flexibility to enhance support practices, hire youths for work, and provide programs that address study-skills enhancement.

3. Functions Added or Deleted

The third aspect is that some functions may be added while other functions may not be included. The example from the mobility section shows that large systems such as C-130s or large vehicles such as High Mobility Multi-Purpose Wheeled Vehicle (HMMWV) should not be included. These large systems support the soldier, but are not an integral part of the soldier himself. Other functions may be added as they are created. The C4I section is developing rapidly in the military and commercial sectors. New technologies are being developed which may have an impact on how C4I will be utilized or conceptualized; they may render some

functions of C4I obsolete. For example, personal night vision devices were not widely available to the soldier until the early eighties.

4. Control and Influence

The fourth consequence suggests that USASOC will need to review the programs and functions it has control or influence over. Control of a program is defined as the sole budgetary authority residing within USASOC. Influence on a program is defined as a shared responsibility or when other users also contribute to the same service or program. BASOPS and joint weapons programs can be put in this category because of the shared nature of the program and the ensuing compromises that come with it. These programs have to please all of the players that contribute funding and authority.

USASOC needs to know which programs it can control through the budget. This has been done to a degree by a cost planning program developed by the U.S. Army Cost and Economic Analysis Center. This Soldier System will tie in more functions, organizations, and quality of life issues than have been previously considered.

C. SOFCOST

The staff for the Assistant Secretary of Defense (ASD) for Special Operations and Low Intensity Conflict (SO/LIC) has a software program called Special Operations Forces Cost (SOFCOST) which is a comprehensive force cost estimating model to develop realistic, current, and supportable cost estimates for Special Operations. The U.S. Army, Navy, and Air Force used data to develop the SOFCOST model program. The application retrieves the official and most current cost estimating data to produce cost estimates for the following events in a force unit life cycle:

1. Acquisition of Resources

2. Activation

3. Annual Operations

4. Movement

5. Inactivation

6. Modification

SOFCOST will produce a cost estimate for any of these events for 129 SOF units described by a unit code. [Ref. 20:p. EXSUM] [Refs. 21 and 22]

The SOFCOST model allows the user to manipulate variables such as geographic location, operational training tempo (OPTEMPO), and base-year dollars. The program will also allow for manipulation of Active, National Guard, or Reserve components. The user can manipulate the variables to tailor the estimate to specific scenarios. [Ref. 20:p. EXSUM] The SOFCOST model prepares five reports. The first report is the Acquisition of Resources report which takes in estimated variables such as type of unit, geographic area, installation, climate zone, training readiness, Authorized Level of Organization (ALO), cost activity, and base year. [Ref. 20:p. 9] The estimated results give an output of resources of material acquisition by equipment; ammunition basic load; organizational clothing and individual equipment; common field equipment and medical items; initial repairable/consumables; repairable (wholesale); and consumables (wholesale). The first estimate also discloses costs associated with personnel acquisition. Personnel acquisition costs are broken down into four cost categories: [Ref. 20:p. A-3] [Refs. 21 and 22]

1. Training through initial specialty

2. Clothing initial issue

3. Accession travel

4. SOF qualification training

The second report discloses the costs associated with activating a unit. The estimate takes into account a unit moving to a new permanent location; asks where and in what type of climate zone the destination is located; and inquires about what Army component it belongs to; the unit training status; and its ALO rating. This report also estimates the transportation costs of moving materiel and personnel to a new location. [Ref. 20:p. A-7- 9] [Refs. 21 and 22]

The third report discloses the operational costs associated with a Special Operations unit. The estimate takes into account a unit's permanent location; fund sources; type of climate zone; unit code and title; what Army component it is; what the unit training status is; and what its ALO rating is. The annual operations report goes into detail on many topics concerning the cost of operating a unit. The report is divided into four main categories: [Ref. 20:p. A-10-13] [Refs. 21 and 22]

1. Direct OPTEMPO

2. Indirect OPTEMPO

3. Personnel

4. Other Unit Support

Direct OPTEMPO brings visibility to the cost associated with training operations and training ammunition/missiles. Training operations estimates aircraft operations, ground operations, and maritime operation costs. Under each of these three categories are three sub-categories which are monitored: 1) repairable; 2) consumables; and 3) Petroleum, Oils, and Lubricants (POL). These three categories cover the line item numbers for every piece of equipment assigned to that unit.

Indirect OPTEMPO estimates varied costs for transportation to training sites, supplies and equipment, travel, and equipment leases. Further, it estimates contractual services, purchased equipment and civilian pay. The Personnel section estimates costs for replacement personnel training, training through initial specialty, clothing initial issue, and Special Operations Forces (SOF) qualification training. It also estimates Permanent Change of Station (PCS) travel costs for both the soldier and his family. Further, it estimates military pay and allowances. Other unit support estimates BASOPS, Real Property Maintenance Activities (RPMA), and family housing costs for the Special Operations Soldier. [Ref. 20:p. A-13] [Refs. 21 and 22]

The fourth report estimates the inactivation of a unit and the reported savings and costs associated with inactivating a unit. Savings are the funding that could be preserved from direct and indirect OPTEMPO, pay and allowances, other unit support, and family housing. The inactivation costs also determine what funding would have to be spent for PCS travel for the military and dependents, and equipment transport. [Ref. 20:p. A-14-16] [Refs. 21 and 22]

D. QUANTIFYING INTANGIBLE ISSUES

It can also be noted that civilian corporations are also wrestling with the idea of quantifying intangible concepts. The following is an excerpt from Fortune magazine, 2 October 1995:

> In the knowledge age, an increasing number of companies find that their greatest assets are in people and ideas rather than in plants and inventory. How do these companies demonstrate to bankers or investors the true worth of their assets? Some are trying to calculate the value of intangible assets using an approach developed by a company called NCI, affiliated with Northwestern University's Kellogg Business School. The technique adapts a method used to evaluate the value of brands, which give their owners a higher return on assets than unbranded competitors. By using a formula that calculates the extra value derived from pricing power, distribution reach, and ability to

> launch new products, you get a measure of a company's "ability to use its intangible assets to outperform other companies in its industry." But you'll still have to get your banker to believe it. [Ref. 29:p. 1]

E. INCREASED SYSTEM INTERACTION

As the ARSOF Soldier System is integrated, it will show that most classes, objects, attributes, systems, and functions, communicate and interact with each other at different levels. Some of these interactions are crucial, whereas others are noncritical but are value added. It is also critical to note that the crucial systems to the soldier must be identified and preserved as the core functions of the entire soldier system. [Ref. 14:pp. 1-13] Identification and prioritization of crucial systems will be determined by the Integrated Product Development Team (IPDT) outlined in the recommendation section of Chapter V. Figure 4-1 is an example of the interactions of the soldier system. [Ref. 14:pp. 1-13]

F. RESULTS OF THEORY

This paragraph will encapsulate what has been discussed in the previous chapters and tie them in to answer the primary and subsidiary thesis questions.

The primary research question was how can the ARSOF soldier be portrayed as a system so that it can compete for resources against other weapon systems? This thesis utilized the Coad/Yourdon and Ivar Jacobson models of object-oriented structures to create a model for the ARSOF soldier so that it could be portrayed as a system. This ARSOF Soldier System model took into account diverse aspects such as soldier equipment and intangible aspects such as quality of life issues and developed a unified system architecture.

The first subsidiary question asked how is the ARSOF soldier portrayed as a system at present? The ARSOF soldier is presently portrayed with the three problem domains of Human resources, Structure, and Materiel as separate entities developing

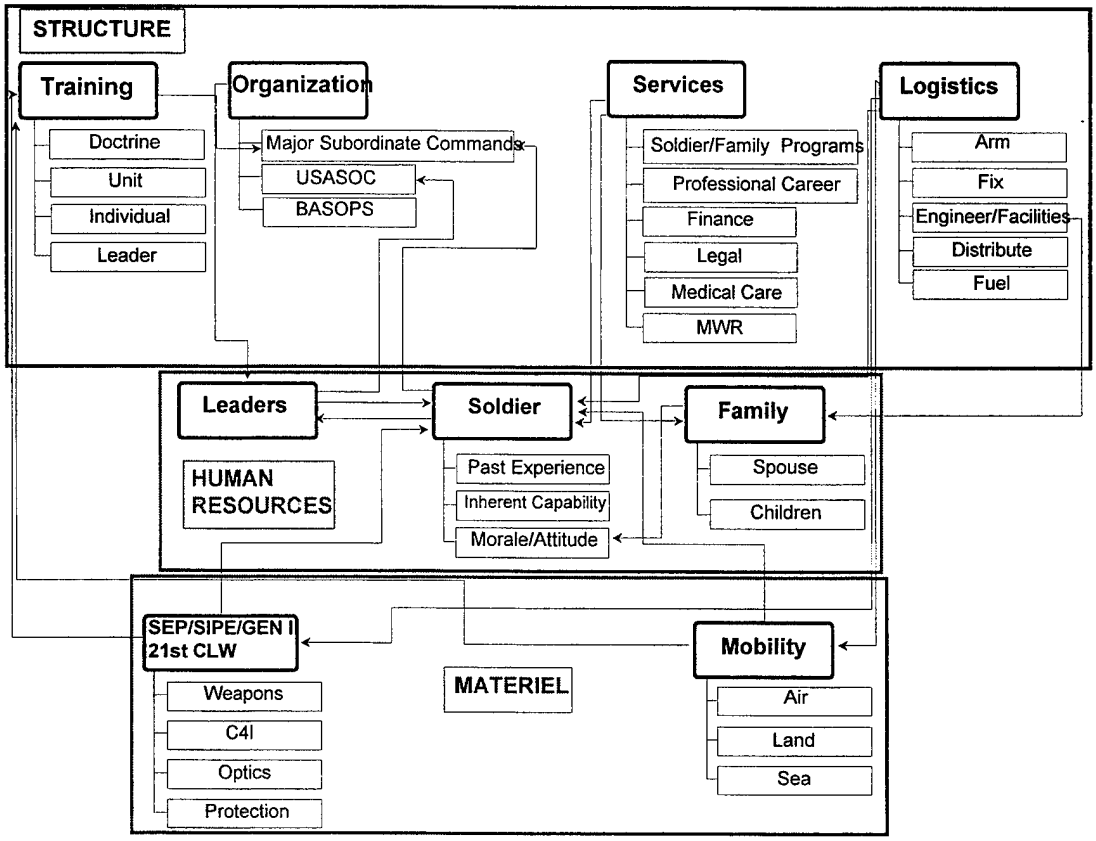

Figure 4-1. Interactions of the ARSOF Soldier System

on their own and pairing up together only at certain times when warranted. The problem domain that everyone is familiar with is the Materiel domain because of the current heavy emphasis on 21st Century Land Warrior and GEN II Soldier programs.

The second subsidiary question asked what is USASOC's vision to portray the soldier as a system? The USASOC vision is to portray the soldier with the materiel aspects and also with quality of life issues included within their system. Their problem was what approach to use to depict a system and how was quality of life going to be included within this system. Once again object-oriented structures helps

to break down the barriers between tangible and intangible objects to help create an all-encompassing system architecture.

The third subsidiary question was what is the proposed system for the ARSOF soldier? This question was answered by the ARSOF Soldier System model depicted in Chapter III.

The fourth subsidiary question was how is USASOC's vision similar or different to the conventional 21st Century Land Warrior? The USASOC vision for a Soldier System takes into account the quality of life issues whereas the 21st Century Land Warrior concentrates primarily on the hardware that a soldier will wear into combat. In essence, the ARSOF Soldier System takes a higher level all-encompassing approach and incorporates the conventional 21st Century Land Warrior as a hardware subset to ARSOF system.

The fifth subsidiary question was how is the proposed USASOC system similar or different to the conventional 21st Century Land Warrior? The USASOC system is similar because it incorporates all of the conventional 21st Century Land Warrior aspects into its Soldier System. In reality, USASOC's acquisition strategy is to leverage as much as possible off of the development from the conventional Army programs because of the reduced development costs and lower cost per unit if procured with the conventional Army.

The USASOC system is different in the aspect that some soldier items will be specialized because of the Special Operations mission profile and therefore may be a low density/high dollar item. The ARSOF soldier also has specific or unique training, equipment, and organizational needs versus the rest of the Army. The ARSOF Soldier System is different because it takes a "whole man" approach which will tie in those quality of life and organizational issues with the hardware aspects of the Soldier System.

The sixth subsidiary question was what part of the ARSOF soldier system would USASOC have control or influence over? This question could not be adequately determined because this thesis cannot fully complete the ARSOF Soldier System down to the attribute level. This is out of the scope of this thesis. However, the SOFCOST program was briefly described to give an approach to determining what control USASOC would have over a complete Soldier System. Once all the parts of the ARSOF Soldier System are determined, a modified SOFCOST program could be templated against the model to determine per unit cost of all the aspects of the Soldier System. This would give USASOC an approach as to what it can control by virtue of what it can budget and allocate towards Soldier System programs.

The seventh subsidiary question was what part of the ARSOF Soldier System would USASOC not have control or influence over? The amount of funding allocation usually denotes where a command will have control or not. For example, many base installation functions are not fully funded by USASOC alone, and therefore are not within its control. In this example, the weight of USASOC's command influence could be used to gain better control.

The ARSOF Soldier System presents a method to construct a system architecture with links made between organizations, functions, equipment, and personnel. This model more fully encompasses the capabilities and functions that are a part of a soldier. These range from the intangible aspects such as experience to tangible aspects such as a M-16 rifle. The theory shows that object orientation is a useful tool to help the planner or developer of systems to come up with a system architecture which both represents what the product should be and is flexible enough to allow for changes and improvements due to revisions in the mission, new technologies, or shifting priorities.

Though systems such as Consolidated Land Warrior, Force XXI, and Installation XXI exist in various stages of development, there are difficulties integrating the three problem domains. There are also issues of what USASOC controls regarding the soldier system. Further, there is the issue of what costs would be entailed by this system. This could be resolved by modifications to the SOFCOST model to allow for variables that do not exist on the present models.

V. SUMMARY AND RECOMMENDATIONS

A. SUMMARY

In summary, the ARSOF Soldier System, through object orientation, is composed of three problem domains: materiel, structure, and human resources. The Materiel problem domain concerns the physical equipment aspects of the soldier system or basically what one person or a crew can carry or use. This narrows the problem domain to equipment which affects the soldier. The Materiel problem domain is sub-divided into the SEP/SIPE/GEN II/21st Century Land Warrior class and a mobility class. The materiel benefits gained from the GEN II/Land Warrior programs contribute to the ARSOF Soldier System. These two classes are then further broken down into objects and attributes which help to further define aspects of the problem domain and classes.

The Structure problem domain concerns the organizations and structures that affect the soldier. This domain is the framework from which other problem domains and classes operate. Structure is sub-divided into the logistics, organization, services, and training classes. The logistics class concerns those actions that maintain and supply the soldier; the organization class concerns how an organizational structure affects the soldier; the services class looks toward the functions or programs that provide quality of life to the soldier; and the training class concerns the effect of training on the soldier in the accomplishment of his mission.

The Human Resources problem domain concerns the people that make up the Soldier System. This is further broken down into soldier, family, and leader classes. The soldier class describes the physical and psychological characteristics of the soldier. Each soldier is born with characteristics which may help or hurt him in

Special Operations. There are also developed characteristics that may enhance a soldier's performance on the battlefield.

The technique for the creation of this system architecture utilizes the object-oriented analysis method. Each of the three problem domains are further broken down into classes, objects, and, finally, attributes. Advantages to object orientation are flexibility and the ability of the objects, classes, and attributes to be reused. The object-oriented analysis approach allows for diverse functions of the soldier to be integrated in a logical manner. Figure 5-1 is a depiction of the ARSOF Soldier System.

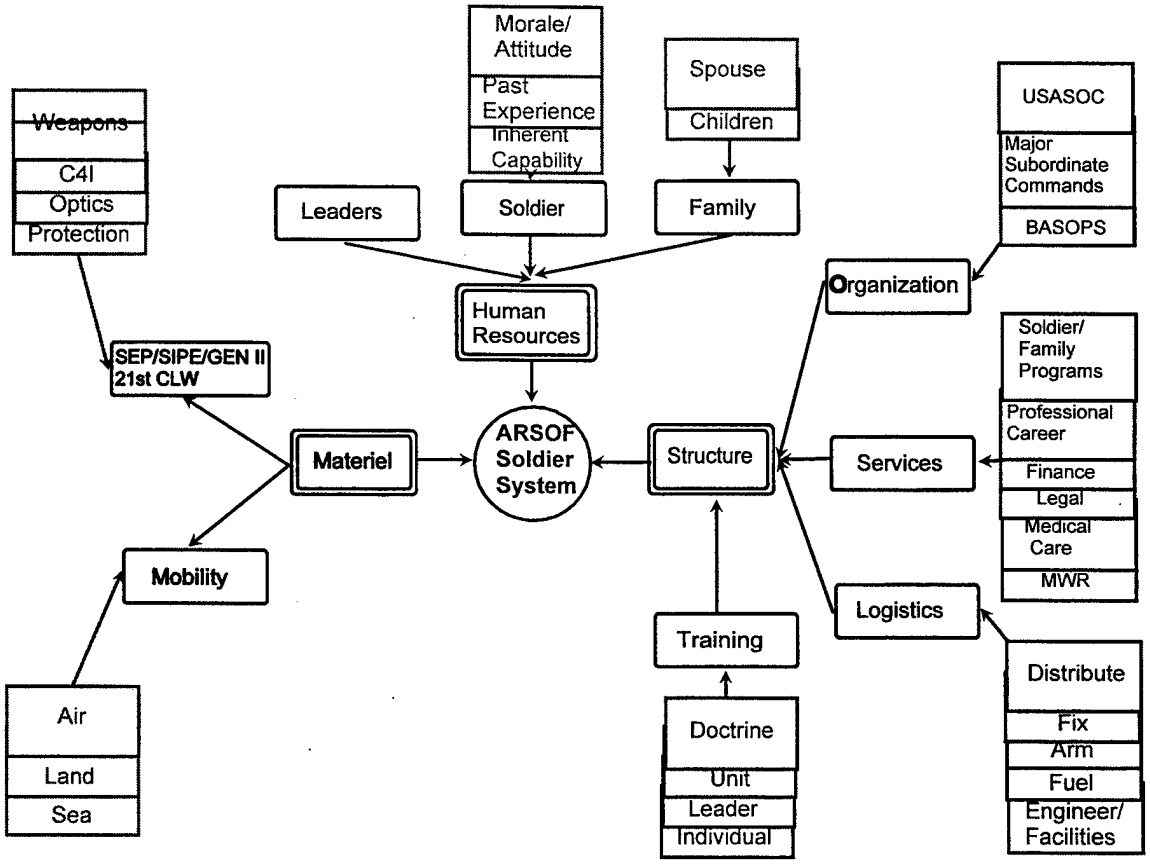

Figure 5-1. ARSOF Soldier System

B. CONCLUSION

There are four conclusions that can be made from this thesis. First, object-oriented analysis can be utilized. Second, various functions and organizations can be tied into the ARSOF Soldier System. Third, quality of life issues can be integrated into this soldier system. Finally, there is a method to tie in classes, objects, and attributes to a Special Operations cost model.

The first conclusion is that object-oriented analysis can be used by the planner, the combat developer, or the system designer to build a system architecture centered around the soldier. The main obstacle is that most people do not understand or have never heard of object orientation. It is not a traditional way of linking ideas and concepts in a traditional military organization. The drawdown of personnel, reduction in the defense budget, and reengineering of military organizations have given this concept a chance to be considered. Organizations without uniqueness and current relevancy are a prime target for reduction, consolidation, and elimination. Organizations that did not work together in the past are now joining together as teams in order to become efficient, relevant, and to provide a quality service or product. Object-oriented analysis allows the linking of ideas and functions that in the past would not have had a direct link under traditional forms of organizing information.

The second conclusion is that the keys to the ARSOF Soldier System are to identify the organizations and functions that are value-added to the soldier and to tie these into the soldier system. This will prevent programs important to the soldier being inadvertently eliminated, help to identify unnecessary programs that cause a drag on the overhead costs of the Soldier System, and have budgetary implications if one can tentatively link these concepts and organizations to the soldier.

The third conclusion is that it is key that the quality of life issues and other intangible, but equally important soldier issues, also be considered in this overall

picture. The current budgetary environment of the Army Special Operations has already forced the materiel systems to tie in with the soldier. Now the structure part of the various systems are also trying to tie in with the soldier through the Advanced Warfighting Experiments (AWE) conducted at the various battle labs. This is where materiel, doctrine, training, and soldiers are melding together to produce a more integrated fighting system.

The fourth conclusion is that there is a method to tie in classes, objects, and attributes to a Special Operations cost model. The focus has always been on preparing the soldier for battle. The problem is that this requires money. Current ways for funding have produced shortcomings for the soldier. When budget dollars are diverted from quality of life, new equipment, and other issues, problems start to occur in the quality and retention of our force. These items are related and thus have an impact on one another. A modified SOFCOST could adequately track and allocate funds to the proper parts of an ARSOF Soldier System.

C. RECOMMENDATIONS

This thesis examines how a planner or developer might construct a soldier system which ties various functions and systems together into a related product. Though it attempts to establish a structure for a soldier system, it is only as good as the one person designing it. The key to a fully encompassing product is to utilize the thinking and experience of others through the use of an Integrated Product Development Team (IPDT). These teams are common today in many fields of business and government. The Soldier System has as much input from different fields as any tank or ship. Therefore, the soldier system needs appropriate integration of related fields so that it will adequately compete for resources against other weapon systems during the budget process.

The first recommendation is for USASOC to create an integrated product development team for the ARSOF Soldier System. This team will need an expert from each of the subject areas that are built into the system architecture. Though they will bring the perspective to others on how their functional area is part of the soldier system, they would not necessarily need a background in the subject area. This would allow for flexibility. Also, USASOC may not have an expert in each field within its own command. This IPDT does not need to be a permanent organization, but is tailored to work on issues when it is deemed necessary. For example, a core group of key individuals would work on this team all year while other individuals would come together during key times during the Mission Area Analysis (MAA) or the budget formulation process. The integrated product development team would consist of the following:

- USASOC Representative
- Training Representative
- User - Representative from the field
- Resource Manager
- Logistics Representative
- Installation Representative
- Soldier and Family Programs Representative.
- Army Special Operations Psychologist
- Force Management Representative.
- Systems Engineer

1. USASOC Representative

The purpose of the USASOC representative is to integrate the input from the various representatives into one ARSOF Soldier System product. This representative would also be responsible for ensuring that the IPDT process and product conform with the guidance from the Commanding General, USASOC. Finally, this person would be responsible for scheduling, hosting, and conducting the overall IPDT process for the ARSOF Soldier System.

2. Training Representative

The training representative is the expert on the various aspects of training within the Army Special Operations community. This person needs to tie the proper training systems to the soldier and to know the priority that these systems have to each other. Redundant or low-priority programs should be dropped or funded last. Thus, the critical training functions with the greatest effect on the overall Soldier System will be identified.

3. The User

The user should be a representative or group of representatives from the field at the current time of the study in order to be brought up to date regarding the activities in which the soldier is engaged. A representative from each Special Forces Group and Army Special Operations organization would be ideal because they have different mission profiles and also different priorities in relation to other units. A compromise would be to get those units posted at Ft. Bragg, North Carolina, to participate or to use some type of video conferencing method. Feedback and research can be conducted through on-going surveys by the Army Research Institute or through command information channels.

4. Resource Manager

The resource manager is the person who will puts the individual cost figures into an overall budget picture for the command to review. This person will also educate the rest of the group concerning the overall mechanics of the budgeting process in order to determine proper costs of each part of the Soldier System. The resource manager is an important part of the team because the budget will highlight tradeoffs needed in the ARSOF soldier design, schedule, and cost. This person will also need to be familiar with the SOFCOST system and be able to give input on how this software program can be modified to give a cost model for the ARSOF Soldier System.

5. Logistics Representative

The logistics representative is the person who ties logistics into the Soldier System. Some parts of the logistics system have an impact on the Soldier System and other parts do not. It is the responsibility of the logistics representative to know the similarities and differences of the Army logistics system and USASOC's logistics system and how they relate to the ARSOF Soldier System.

6. Installation Representative

The installation representative has expertise in matters of the utilization of post facilities. Categories such as housing, electricity, water, and facilities would be handled by this person. This person would also determine the parts of the military community that tie in with or have an influence on the soldier. The Installation representative will also determine what programs USASOC is able to control or influence.

7. Soldier System Representative

The Soldier System representative is the expert on the development of soldier systems such as 21st CLW, GEN II Soldier, SEP, and SIPE. This person would be

current with the activities of PM Soldier, Soldier Systems Command, and Natick Research Lab and whether or not they would fit within the needs of the Army Special Operations community.

8. Soldier and Family Programs Representative

This representative would be informed about the programs occurring within the civilian and military community that have an affect on the soldier, his family, and his leaders. This person would identify and prioritize programs, and determine the cost elements for each program. This person would also know the components that belong to this part of the ARSOF system and the depth of involvement. This is difficult because many of these programs have not been traditionally included with the Soldier System, and the cost benefits to the soldier are difficult to quantify.

9. Army Special Operations Psychologist

The Army Special Operations Psychologist knows the factors and qualities that are sought in the soldier being recruited, and the qualities and characteristics needed to retain soldiers within the Army Special Operations Community. This person would also be aware of the incentives to use in order to recruit and retain the soldier. This area is also difficult to quantify.

10. Force Management Representative

This representative is an expert on the organization of USASOC. This person would be aware of the current initiatives being conducted by Force XXI and the Battle Labs which have an effect on the force structure and fighting capabilities of the ARSOF soldier.

11. Systems Engineer

This representative would design the ARSOF Soldier System with object-oriented analysis or structures, provide updates, and keep it within a Special Operations perspective. This person would also be able to give the other group

members a perspective on what object orientation can do and how it pulls together all of these separate issues into one system.

12. IPDT Subgroups

In order to maintain a better control of the IPDT process, the formation of IPDT subgroups is recommended. The overarching IPDT could consist of the USASOC representative, the resource manager, and the systems engineer. The Structure subgroup could consist of the training representative, logistics representative, soldier and family programs representative, installation representative, and the force management representative. The Human Resources subgroup could consist of the user and the Army Special Operations Psychologist. The Materiel subgroup would consist of the Soldier System representative. These groups could be adjusted as necessary. The idea is to reduce the span of control needed to maintain forward progress with the various members of the IPDT.

D. MODEL INSERTION INTO THE MAA AND BUDGET FORMULATION PROCESS

The second recommendation is to put ARSOF Soldier System model into the budget formulation process so that it will adequately compete for resources against other weapon systems. The ARSOF Soldier System should be exposed to the rigors of the Mission Area Analysis (MAA) process in order to have adequate input and visibility. The MAA identifies battlefield deficiencies which are integrated and prioritized to identify requirements for new doctrine, training, organizations, and materiel. The MAA must consider current capabilities, history, doctrine, and technology as they relate to current threat capabilities. The ARSOF Soldier System has parts of it that belong to current programs, supporting architectures, conditions and standards, and force structure baselines that need to be reviewed for relevancy within USASOC mission profiles during the MAA process. [Ref. 38] The ARSOF

Soldier System will also show the link that various programs, functions, and organizations have to the soldier and why in the end they will have an impact on the soldier and unit readiness. The goal is to have a solution set that involves Doctrine, Training, Leader Development, Organization, Materiel, and Soldiers (DTLOMS) with an adequate resource estimate. [Ref. 39]

This model will contribute to the development of a budget formulation process in which the war fighters will have an opportunity to identify and prioritize the financial resources needed to conduct operations. This may require an adjustment of resources, a reprioritization of the threat and operations, and possible changes to the organizational structure. Finally, it will lead to the Program Objectives Memorandum (POM) which will then contribute to a ready Special Operations Force. The ARSOF Soldier System will then be a part of this process and will have adequate visibility to compete for resources against other traditional weapon systems. [Ref. 39]

APPENDIX. SYSTEM ARCHITECTURE CONSIDERATIONS

Protection

Helmet

Hats/Caps

Battle Dress Uniforms (BDU)

Undergarments

Gloves

Socks

Footwear

Laser Protection Glasses

Impact Resistant Glasses

Hearing Protection

Sunscreen

Insect Spray

Scarf

Nuclear, Biological, Chemical ensemble

Body armor

Immunizations

Cold Weather Clothing

Hot Weather Clothing

Homes

Barracks

Battle Positions

Tents

Sleeping Bags

Poncho/Rain Gear

Entrenching Tool

Physical Training Uniform

Sneakers

Command and Control

Watches

Radios

Compass

Protractor/Map

Signaling devices

Computers

Pace counter

Altimeter

Temperature gauge

Orders

Field Orders

Fragmentary Orders (FRAGOS)

Pen/pencil

Target Acquisition

Night vision goggles

Scopes

Binoculars

Thermal Imagery

Identification Friend or Foe

Sensors

Sustainment

Rucksack

Food

Water

Air

Load Bearing Equipment

Ammunition

Pay

Morale, Welfare, Recreation (MWR)

Family Support Groups

Specialty/Incentive pay

Hazardous duty pay

Temporary Duty (TDY)

Chaplain Services

Sleep/rest

Promotion

Assignments

Schools/Education

Medication

Weapons oil

Post Exchange (PX)

PX/Commissary

Batteries

Medical Aid Bag

Self Contained Underwater Breathing Apparatus gear

Concealment

Camouflage sticks

Camouflage pattern

Ghillie suit

Camouflage nets

Maintenance

Medical physicals

Counseling program

Medical treatment

Physical fitness

Legal services

Financial services

Transportation/Delivery/Mobility

Helicopters

Airplanes

Ground vehicles

Parachutes

Motorcycles

All-terrain vehicles

Rubber boats/kayaks

Animals

Lethality

Pistols

Machine guns

Grenades

Mortars

Knives

Artillery

Close Air Support

Demolitions

Mines

Anti-tank weapons

Training

Leader training

Military Occupational Specialty (MOS) training

Special skill training

Exercises

Tactical Exercises Without Troops

Schools

Doctrinal training

Language training

Cultural training

Experience

Organization

U.S. Army Special Operations Command (USASOC)

U.S. Army John F. Kennedy Special Warfare Center and School (USAJFKSWCS)

Special Forces Command

Special Forces Group

Special Forces Battalion

Special Forces Company

Special Forces Detachment

Base Operations (BASOPS)

Army Structure

Sequences

Mission Planning Sequence

Equipment Life cycle

Military Installation Operating Cycle

Career Cycle

Personal

Soldier

Family

Leaders

Terms

Disable/Destroy Enemy

Move the soldier

Protect the soldier

Sustain the soldier

Maintain the soldier

Train the soldier

Receive/Analyze/Provide Intelligence/Information

Command

Control

Communications

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5. Dr. Orin E. Marvel (Code C3) 1
   Naval Postgraduate School
   Monterey, CA 93943-5100

6. LTC Keith Snider (Code SM/Sk) 3
   Naval Postgraduate School
   Monterey, CA 93943-5103

7. Dr. David Lamm (Code SM/Lt) 5
   Naval Postgraduate School
   Monterey, CA 93943-5103

8. Mr. Odie Knight 1
   ATTN: USASOC-Chief, Systems Integration Division (AORI)
   Ft Bragg, NC 28307-5200

9. U.S. Army Research Institute for the Behavioral and Social Sciences ... 1
ATTN: PERI-TA (Dr Jaquelyn Scarville)
5001 Eisenhower Avenue
Alexandria, VA 22333

10. U.S. Army Research Laboratory 1
ATTN: AMSRL-HR-MB (Dr Laurel Allender)
Aberdeen Proving Ground, MD 21005-5059

11. CPT Donald D. Ottilige 2
P.O. Box 554
Portsmouth, RI 02871