Reliability of Load Bearing Systems

An Interactive Qualifying Project Report

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Abstract

As the technology of war advances the loads carried by United States infantrymen have increased. These excessive loads, often well over 100 pounds, have limited the combat effectiveness of Marines. The current load bearing systems used to carry equipment into battle do not sufficiently meet the requirements of the United States Marine Corps. This project focuses on the impact of heavy load bearing systems on the Marine Corps's war fighting philosophy. A brief history of load bearing systems used by the United States Arm Forces is presented. Recommendations for the development of light and resilient load bearing systems for modern warfare are presented as well.

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Chapter 1: Fundamentals of War and Combat Loads

1.1 Introduction

If you set a fully equipped army in march in order to snatch an advantage, the chances are that you will be too late. On the other hand, to detach a flying column for the purpose involves the sacrifices of its baggage and stores.[1] *–Sun Tzu*

Sun Tzu is arguably the most influential war theorist of all time. Written circa 500 B.C., *The Art of War* at times may seem outdated but its theories have proven to be timeless. This dissertation has influenced the way Military Commanders worldwide have conducted war throughout history. This particular quote pertains to the risks of overloading the common foot soldier.

1.2 War Fighting Concepts

To fully understand and grasp how overloading combat troops affects war fighting, we must first look at the fundamentals of war. Since this project is tailored to the analysis and improvement of the load carrying equipment of the United States Marine Corps, understanding the implications of overloading Marines is critical. The Marine Corps publishes a doctrine specifically on war fighting, *Marine Corps Doctrinal Publication 1: Warfighting.* This publication is a philosophical and tactical foundation for how the Marine Corps trains and prepares for combat.

The nature of war includes many concepts such as friction, complexity, and physical, moral and mental forces. Friction, as in science, is the force that resists all action and depletes energy. It makes simple tasks difficult to accomplish, and difficult tasks nearly impossible.

[1] Tzu, Sun

Friction can be anything from lack of hydration to communication problems during a complicated tactical maneuver. Great stress and strain is placed on combat troops by requiring them to carry excessive weight over great distances, and for long periods of time. Overloading, whether necessary or not, creates friction, further increasing the difficulty of mission accomplishment.

War is multifaceted, involving many variables between opposing forces[1]. Each force has a unique structure, employing various substructures within themselves. This complexity is derived from the fact that war is not driven solely by the acts of the individual troops; it is governed by the collective behavior of the entire system and all its parts. Modern day war fighting requires forces to distribute heavy equipment amongst its units, leading to the overloading of troops. This extra load on the individual troops directly impacts the larger group's performance.

Prussian General Carl von Clausewitz described war fighting as a sword: the handle, representing the physical forces, and the blade, the moral and mental forces[2]. These physical forces consist of troop numbers, equipment, and general size of the fighting force. The moral and mental forces include the human dimension of war. People are affected by violence, danger, and other intangible components of combat. A commander must also consider these forces in addition to the physical forces his men encounter. The mental and moral forces comprise of two thirds warfare; it would be a grave mistake to not recognize the impact loads have on the morale and well being of troops. If this friction becomes unbearable, they will begin to concentrate on

[1] United States Marine Corps. Warfighting
[2] Clausewitz, Carl von

overcoming mental and physical fatigue, rather than focus on fighting and defeating the enemy. These concepts of the nature of war have been constants throughout history.

The theory of war is the way the Marine Corps prepares to wage war. It is a decision made by leadership, and evolves as warfare changes. Major concepts of the theory of war include: combat power, speed, surprise, and flexibility[1]. All are connected and rely heavily on the ability of troops to move rapidly.

The total destructive force of a unit at any given time is its combat power[1]. This is directly related to what can be carried by individual troops. The more equipment troops can carry, the more assets a unit can bring to the fight. This further increases the combat power of a unit. However, by carrying too much the troops are negatively affected by fatigue, hampering the destructive force of the unit.

Speed is swiftness in actions, and is relative to the enemy's movement pace. Speed is a weapon in the Marine Corps[1]. A unit must move faster than its counterpart to win an engagement. Speed allows a unit to develop a rapidly deteriorating situation for the enemy, limiting their ability to counterattack. Many great commanders, such as Napoleon and General George Patton, impressed upon their troops the importance of speed in victory. Among other things, speed is used to surprise and attack the enemy where they least expect it. The benefit of surprise is that it delays the enemy's reaction time. A unit's speed will be directly affected by the weight carried by the individual troops. As troops are given heavier loads their speed will decrease and limit their ability to use speed as a weapon to surprise the enemy. Speed provides a unit the ability to exploit an opportunity of enemy vulnerability. The capacity to attack an

[1] United States Marine Corps. Warfighting

enemy at a decisive time in a battle is a key function of leadership that should not be overlooked. This ability is a function of the speed of a unit, and is directly affected by the weight put on the individual troops. Flexibility of a force is related to its potential to react to the various situations it encounters. In order to react swiftly, a force must always be properly equipped and ready to move. This directly correlates with the load placed on individual troops.

Although many of the concepts of the Marine Corps war fighting philosophy have been covered in detail, it should be noted that the entire doctrine is based on maneuver warfare. This style of war fighting involves analyzing the enemy as a system, and not solely by its combat assets[1]. Using this concept, the Marine Corps finds the enemy's center of gravity. This is the enemy's chance for success, which can be destroyed by exploiting their critical vulnerability. The critical vulnerability of the enemy is the weakness that if exploited will take down the enemy's center of gravity. Maneuver warfare relies on all these concepts, especially the ability to move rapidly. Part of this is based on the decision making of leaders, but the majority of a unit's speed depends on the equipment used to carry the necessary tools to fight the enemy.

Speed and mobility are essential to modern combat. Without the proper ability to move assets around the battlefield, the Marine Corps would be unable to carry out its primary mission of being a strike force. The effectiveness of Marine Corps infantry packs is paramount to mobility and ultimately mission success.

1.3 Marine Corps Rifle Company

The control of a large force is the same in principle as the control of a few men: it is merely a question of dividing up their numbers[2]- Sun Tzu

[1] United States Marine Corps. Warfighting
[2] Tzu, Sun

Sun Tzu understood that the size of a force does not matter as long as the leadership understands the task at hand and divides and structures the fighting force appropriately to accomplish the task. Along with understanding the war fighting philosophy of the Marine Corps it is also necessary to understand how it is structured as a fighting force. The largest Marine fighting unit is the Marine Air Ground Task Force (MAGTF). It is comprised of a command element, ground combat element, air combat element, and a logistics element. This includes everything from aircraft to artillery and is capable of engaging in full-scale battle. The smallest MAGTF in the Marine Corps is the Marine Expeditionary Unit (MEU). There are currently seven MEUs deployed overseas.

The ground combat element is the section of a MEU that contains the infantry segment. The infantry is the section of the Marine Corps that conducts combat operations on the ground. These are the men that carry packs into combat and will be most prone to overloading. The MEU ground combat element is an infantry battalion, which is made up of three rifle companies and a weapons company. Due to the fact that this report focuses on the loads being carried by individuals, it will not go into detail on any level above a rifle company.

A rifle company is comprised of approximately 200 Marines. The primary mission of a Marine rifle company is to locate, close with, and destroy the enemy by fire and maneuver or to repel his assault by fire and close combat[1]. A Marine rifle company contains three rifle platoons and a weapons platoon as shown in figure 1.

[1] United States Marine Corps. Tactics

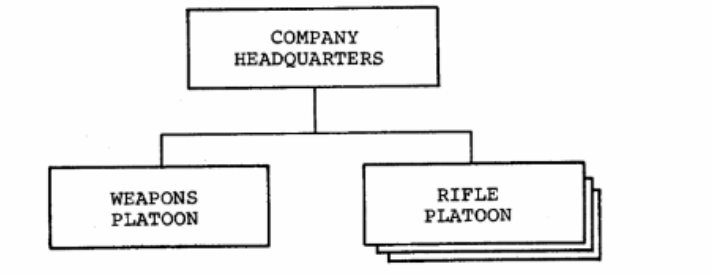


Figure 1: ***Rifle Company Structure***[1]

The rifle platoon is the basic maneuver element of a rifle company, and the Marine Corps's style of war fighting makes it a critical component[2]. The weapons platoon provides the fire support and often tasks out its sections to platoons as needed. Of all the platoons, the weapons platoon is most susceptible to overloading. This is because it is responsible for providing fire support for the rest of the company. Mission tasking requires Marines in weapons platoon to carry heavy weaponry, such as 50 caliber machine guns and 60mm mortars.

A rifle platoon is arranged into three squads, each containing three fire teams. In each squad there will be specific weapons and loads prescribed to each fire team, and subsequently each Marine. Figure 2 shows the structure of a rifle platoon.

[1] United States Marine Corps. FMFM 6-4
[2] United States Marine Corps. Tactics

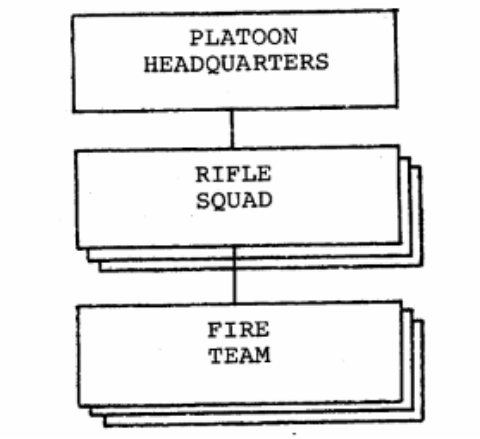


Figure 2: ***Rifle Platoon Structure***[1]

On average, each fire team consists of a team leader, automatic rifleman, assistant automatic rifleman, and a rifleman. The team leader is in charge of the fireteam. In addition to carrying an M-16 with an M-203 40mm grenade launcher attachment, he may be required to carry other mission critical items. The automatic rifleman carries an M-249 Squad Automatic Rifle (SAW). He splits the weapons load and ammunition between himself and the assistant automatic rifleman, who also carries an M-16. The rifleman carries an M-16, and is the most junior member of the fireteam[2].

The weapons platoon in a rifle company is organized into three sections: the assault section, the 60mm mortar section, and the machine gun section. They are all subdivided into three squads, as displayed in figure 3.

[1] United States Marine Corps. FMFM 6-4
[2] United States Marine Corps. Marine Rifle Squad

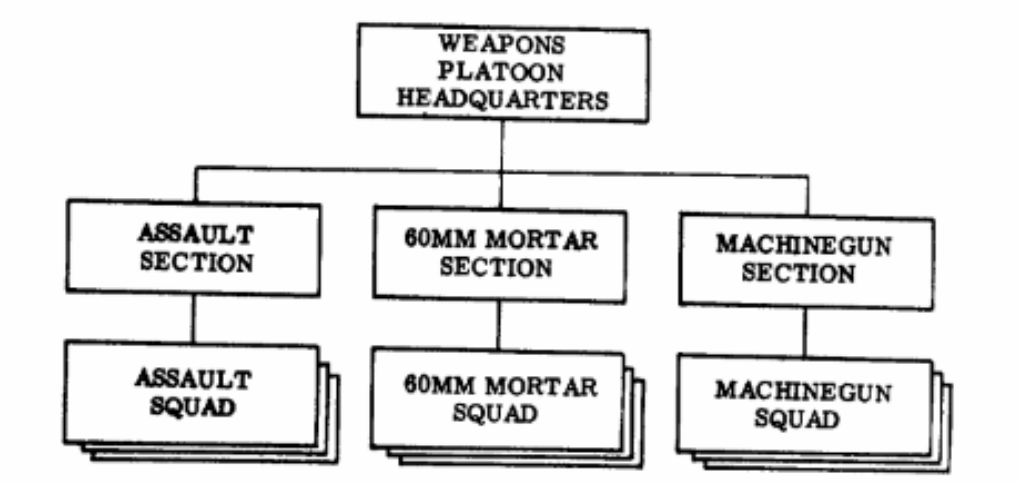


Figure 3: ***Weapons Platoon Structure***[1]

The squads in a weapons platoon are not comprised the same way as a rifle platoon. In the assault section there are six Shoulder-launched Multi-purpose Assault Weapons (SMAW), each deployed by the three assault squads. The 60 mm mortar section is made up of three squads. Each squad is responsible for a 60 mm mortar, making a total of three 60 mm mortars per weapons platoon. There are six 7.62 mm machine guns in the platoon, which are divided evenly among the three machine gun squads[2]. All of these weapon systems require more than one Marine to carry and operate.

1.4 Fighting and Existence Load Concept

In the mid-1950s, during the design phase of the new M-1956 Load Carrying Equipment (LCE), the concept of combat loads first appeared. It was realized that combat troops should only carry the equipment and gear necessary to complete the mission at hand. The mission, terrain, weather, and other factors dictate what gear is essential to each mission. Carrying unnecessary equipment hinders a Marine unit's combat effectiveness by reducing their mobility

[1] United States Marine Corps. FMFM 6-4
[2] United States Marine Corps. Tactics

and speed. This produces friction, and limits its ability to accomplish the mission. All military load bearing systems used by the Marine Corps, from Vietnam to present, utilize this concept.

Combat loads are split into three types: the assault load, approach march load, and the existence load. The assault load is the smallest load, and contains only the items necessary to assault an objective. This includes water and ammunition, restricting what is brought into combat. Limiting combat loads while assaulting through an objective is critical to maintaining a Marines combat effectiveness. This prevents them from becoming overworked during dangerous evolutions. Table 1 is a list of typical items that will be found in the assault load.

Clothing Worn & Packed	**Weight (Lbs)**	**Quantity**	**Total Weight**
Helmet, Personnel Armor System, w/ Cover and Band	03.600	1	3.600
Gloves, Black Leather	00.330	1	0.330
Glove Inserts (Wx specific)	00.150	1	0.150
		Total	**4.080**
Load-Carrying Equipment	**Weight (Lbs)**	**Quantity**	**Total Weight**
Fighting Load Carrier (FLC)	02.000	1	2.000
Interceptor Body Armor (Outer Tactical Vest)	08.400	1	8.400
3 Double Magazine Pockets, 2 Grenade Pockets, 1 Utility/Canteen Pouch	01.900	1	1.900
Patrol Pack	02.425	1	2.425
		Total	**14.725**
Weapons, Ammunition, and Optics	**Weight (Lbs)**	**Quantity**	**Total Weight**
Service Rifle, M16A2	07.900	1	7.900
Sling, M16A2	00.420	1	0.420

Ammo Magazines, M16 (7) (.027 lbs/rd; .24 lbs/mag)	01.050	7	7.350
Bayonet, M7 with Scabbard	01.300	1	1.300
Grenade, Hand, Fragmentation, M67 (2)	02.000	1	2.000
		Total	**18.970**
Sustainment and Other Equipment	**Weight (Lbs)**	**Quantity**	**Total Weight**
Paint, Face, Camouflage Stick	00.140	1	0.140
Flashlight with Red/Blue Lens and Extra Bulb	0.500	1	0.500
Goggles, Sun, Wind, and Dust	00.150	1	0.150
Ear Plugs with Case	00.100	1	0.100
1st Aid Kit	01.000	1	1.000
		Total	**1.890**
Chow and Water	**Weight (Lbs)**	**Quantity**	**Total Weight**
100 Oz Hydration System (Filled)	6.906	1	6.906
MRE	01.300	1	1.300
		Total	**8.206**
Total Assault Load WT (LBS.)			**47.871**
Obj. WT (Combat Load Report)			**50.70**

Table 1: ***Assault Load***[1]

The next load is the approach march load. This includes the assault load in addition to necessary equipment for troops to conduct extended combat operations. This load is used when troops have daily access to resupply. Because the load is designed to be carried for long distances and is heavier than the assault load, it is not usually used in combat. It is designed so

[1] hqinet001.hqmc.usmc.mil/.../**COMBAT**%20**LOAD**%20REPORT%7BDraft%2031%20Dec%2003

that the average infantry Marine can carry out a 20 mile hike over eight hours and still maintain a 90% combat effectiveness. Table 2 is a chart containing the elements in a generic approach march load.

Clothing Worn & Packed	**Weight (Lbs.)**	**Quantity**	**Total Weight**
Extra Socks, Combat	00.160	2	0.320
Poncho	01.600	1	1.600
Poncho Liner	01.600	1	1.600
		Total	**3.520**
Load-Carrying Equipment	**Weight (Lbs.)**	**Quantity**	**Total Weight**
Main Pack and Frame to include shoulder suspension system & hip belt	8.075	1	8.075
		Total	**8.075**
Sustainment and Other Equipment	**Weight (Lbs.)**	**Quantity**	**Total Weight**
Entrenching Tool w/case	02.500	1	2.500
Tooth Brush with Tooth Paste	00.300	1	0.300
Chap Stick	00.010	1	0.010
		Total	**2.810**
Chow and Water	**Weight (Lbs.)**	**Quantity**	**Total Weight**
Canteen, 1 Quart (Filled) w/ MOLLE Compatible	02.475	2	4.950
MRE	01.300	3	3.900
		Total	**8.850**
Approach March Load			**23.225**
+ Assault Load			47.871
Total Approach March Load WT (LBS.)			71.126

Objective WT (Combat Load Report)	76.126

Table 2: ***Approach March Load***[1]

The largest load that a Marine typically carries is the existence load, and has the most gear and sustainability. This load is used when immediate resupply is not available, and contains all necessary items for a Marine to live off of. Because of the large amount of supplies and gear included in the existence load, it is assumed that the Marine will only be moving it short distances. This is usually just from the original point to the assembly area, where the mission starts. Table 3 is a chart containing the items included in the Marine Corps existence load.

Load Carrying Equipment	**Weight (Lbs.)**	**Quantity**	**Total Weight**
SAPI Plates (Front and Back)*****	08.000	1	8.000
		Total	**8.00**
Sustainment and Other Equipment	**Weight (Lbs.)**	**Quantity**	**Total Weight**
Mask, M40 w/Hood, Carrier & Water Proof Bag, Canister Filter C2A1	04.190	1	4.190
		Total	**4.190**
Weapons, Ammunition, and Optics	**Weight (Lbs.)**	**Quantity**	**Total Weight**
Infantry Weapon Night Targeting Device, AN/PAQ-4C w/ Batteries *****	00.800	1	0.800
Night Vision Monocle, AN/PVS-14 w/Batteries *****	01.000	1	1.000
		Total	**1.800**
Chow and Water	**Weight (Lbs.)**	**Quantity**	**Total Weight**

[1] hqinet001.hqmc.usmc.mil/.../**COMBAT**%20**LOAD**%20REPORT%7BDraft%2031%20Dec%2003

Canteen, 1 Quart (Filled) w/ MOLLE Compatible	02.475	2	4.950
MRE	01.300	3	3.900
		Total	**8.850**
Emergency Approach March Load Items			**22.84**
+Assault Load			47.871
+Approach March load			23.225
Total Sustained March Load WT			**93.936**
Objective WT(Combat Load Report)			**101.400**

Table 3: ***Existence Load***[1]

These load concepts have been an integral part of the Marine Corps war fighting philosophy since the Vietnam era. Technological advancements, in areas such as weaponry and body armor, have increased the need to bring more gear into combat areas. This drastic change in combat load weight spurred new interest in pack weight distribution. The ALICE, MOLLE, and ILBE pack systems are the result of extensive research into the origin and purpose of combat loads.

[1] hqinet001.hqmc.usmc.mil/.../**COMBAT**%20**LOAD**%20REPORT%7BDraft%2031%20Dec%2003

Chapter 2: Evolution of the Pack

2.1 Early Packs

WWI Soldiers at basic training[1]

2.1.1 M-1928

2.1.1.1 Development

The pack used by the Marine Corps during WWI was the M-1910 Haversack. This pack serves as the foundation for several generations of packs utilized by the Marine Corps. It was used to carry the bare essentials: food, water, utensils, clothing, tents, blankets, an entrenching tool and ammunition[2]. The size of the M-1910 is relatively small compared to contemporary

[1] Pershings' Doughboys WW1 U.S. Army Living History Group
[2] WWII Packs: M-1928

packs, and it lacks a frame structure to provide back support. The main focal point of the packs design was centered on the wool blanket provided to all Marines. This required the pack to be 'wrapped up' around the blanket, making a seemingly simple task take much longer than necessary to accomplish[1].

M-1910 Haversack[2]

These inherent weaknesses were purposely incorporated into the packs design with the tactical needs of the time in mind. Battles during WWI were large scale, and deteriorated into trench warfare over time. Unlike contemporary battle, where the battle front is not always clear, the battle lines were well defined and did not require individual troops to carry as much equipment as placed on our current forces. The battle lines advanced much slower, requiring individual Marines to carry less food and water on their person. When units did move, they were well supported by nearby logistic and ground units. The pace and nature of war during this

[1] How to Pack the M-1928 Haversack
[2] WWII M-1928 Haversack Complete

period was drastically different from contemporary fighting, and thus the pack did not provide capabilities that units did not need.

The M-1910 was upgraded to the M-1928 during WWII. Among the previous provisions provided by the M-1910, several additional straps, hooks and attachment points were added to the exterior of the pack. These provided ways to bring additional gear such as pistols, cartridge belts, bayonets, and helmets to the fight, along with all previous gear the M-1910 was required to hold[1]. Most of these straps and attachment points were designed for use by specific gear, and required gear to be stowed in a specific manner to accommodate all gear it was capable of carrying.

2.1.1.2 Specifications

The M-1928 provided additional hooks and straps the M-1910 lacked, but beyond that did not differ much in design. All components of the pack were made with cotton.

[1] WWII Packs: M-1928

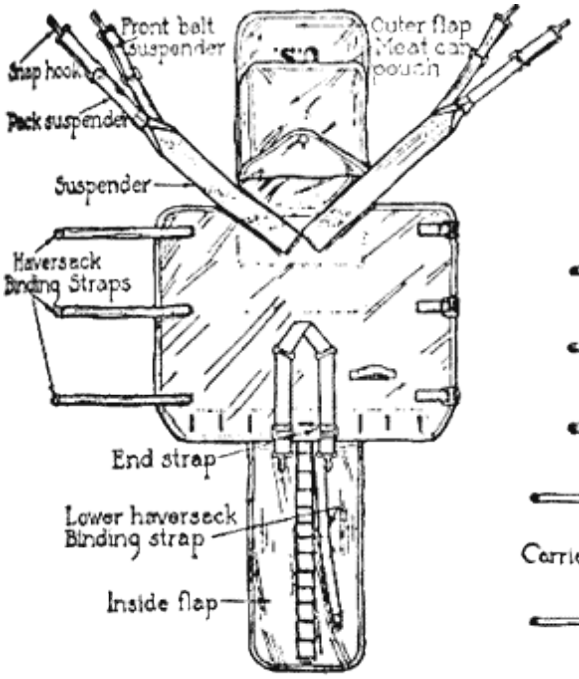


Plate 82. The Haversack.

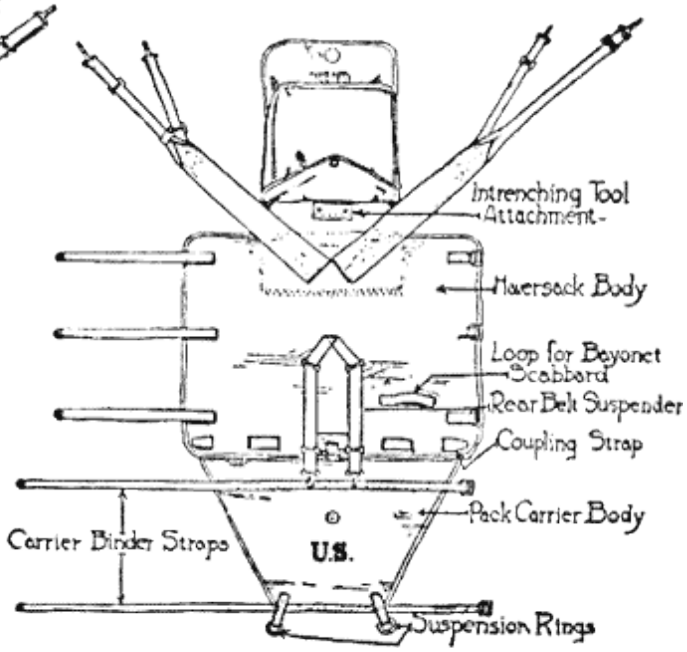


Plate 83. Haversack with Pack Carrier Attached.

M-1928[1]

Major Components:[2]

Main Storage Pouch- Pack Carrier

Meat Can Pouch
Internal Pockets

Straps

-Haversack binding straps

-Carrier binding straps

-Front pack suspenders

-Rear belt suspender

-Coupling strap

Bayonet Loop

[1] How to Pack the M-1928 Haversack
[2] WWII Packs: M-1928

Major Gear:[1]

Food rations

Canteen

Utensils

Clothing/Uniforms

Blanket

Tent and stakes

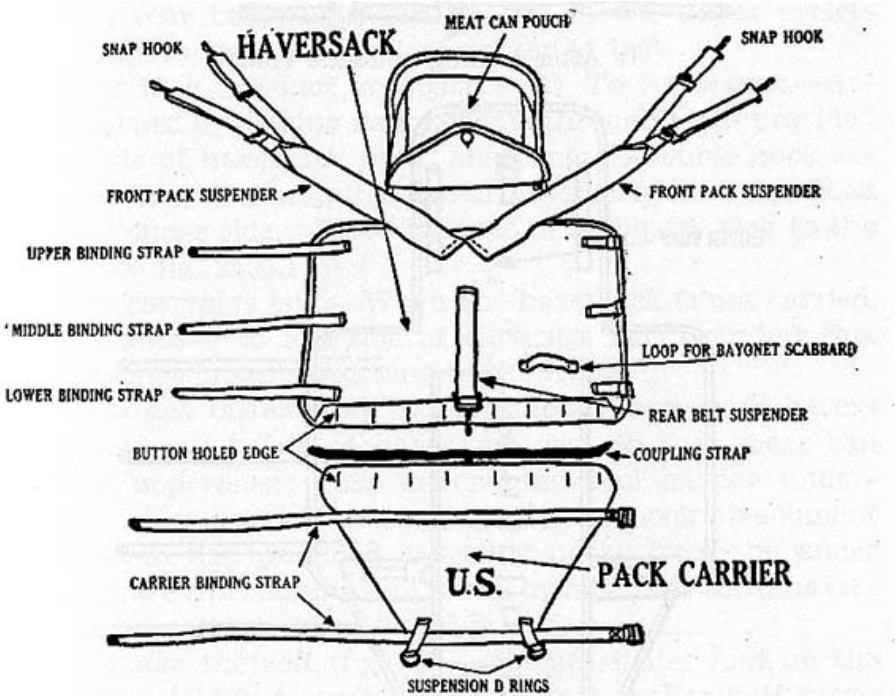
Ammunition
Bayonet

Entrenching Tool

Helmet

Raincoat

Toiletries



M-1928[1]

[1] WWII Packs: M-1928

2.1.1.3 Military Service

The M-1928 was used by both the Army and Marine Corps during WWII. Due to its complexity and lack of water resistance, it was strongly unfavorable by Soldiers and Marines. Assembling the pack took several minutes to complete. This process involved using the coupling straps, which were threaded through button holes. Then the suspender straps had to be attached to the cartridge belt. This part had to be completed after all food, clothing, and blankets were placed in the pack in specific locations, in specific orders. This made gear difficult to access, and the entire pack had to be disassembled to use them. The lack of storage space, complexity of use, and focal point of design (wrapping around the blanket), would be addressed in future pack designs.

2.1.2 M-1961

2.1.2.1 Development

The problems the M-1928 had would be fixed with the M-1961 Load-Bearing Equipment (LBE). This system utilized equipment that could be easily integrated or removed from the system at ease. This provided adaptability to a multitude of situations at a moment's notice. One of the greatest upgrades this system provided was the integration of M-1928 capabilities and the storage space Rucksacks provided.

One of the key issues that needed to be addressed was the lack of carrying space the M-1928 provided. During WWII the Mountain Rucksack was developed for such purposes. It was the first of its kind, allowing greater space for storage and an external frame as support. Many of the complaints for this pack came from weight distribution problems within the pack, and on the body. The Mountain Rucksack was intended to carry extra gear needed for mountainous terrain,

[1] How to Pack the M-1928 Haversack

and the Army was navigating cliffs and skiing through regions when needed[1]. The awkward distribution within the pack made it difficult for troops to maintain their balance and was detrimental to mission accomplishment.

WWII Troops utilizing the Mountain Rucksack[2]

Further developments from Natick Labs created the ARVN Rucksack. This pack utilized a non water-resistant cotton fabric, and had a steel X-frame for its supporting device. It provided two external pouches in addition to the main pouch, providing a large amount of carrying space for soldiers. Main issues that arose with this pack were projections from the external frame that caught in underbrush frequently, and the water absorption from the cotton material the pack was made of.

The problems the ARVN Rucksack had were compounded during Vietnam, and led to the development of the Tropical Rucksack.

[1] U.S. Army Rucksack of WWII
[2] U.S. Army Rucksack of WWII

Tropical Rucksack[1]

The Tropical Rucksack provided additional space for storage, and was constructed with water-resistant material. Among these benefits, it was also constructed to be compatible with the M-1961 LBE system.

The M-1956 Load Carrying Equipment (LCE) system was developed to upgrade the capabilities provided from the M-1928. It utilized a new "web gear" system, which allowed easier integration of different equipment. The belt contained many rings that allowed new equipment to be hooked on[2]. This simple approach to modularity was extremely beneficial to all forces in Vietnam.

The M-1956 was upgrade to the M-1961 during Vietnam to provide additional water resistance to the external pockets, and extra rings on the field pack so more gear could be hooked on if necessary. Both the M-1956 and M-1961 were compatible with the Tropical Rucksack,

[1] Tropical Rucksack
[2] M-1956 Load-Carrying Equipment

setting the standard for future pack systems. The original design from the M-1956 did not alter much, and remained this way until the ALICE system was developed later during Vietnam[1].

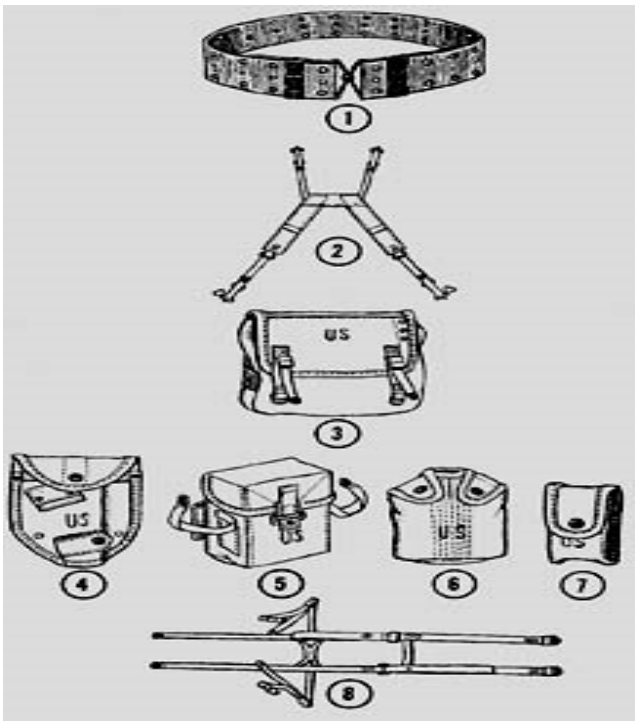
2.1.2.2 Specifications

The M-1961 system consisted of equipment that could be easily attached and detached from the system, depending on the needs of the environment forces were acting in. This system complimented the storage space provided by the Tropical Pack, and made key supplies such as water and ammunition readily available for all troops.

M-1961 Major Components:[2]

1. Belt
2. Load-Bearing Suspenders
3. Field Pack
4. Entrenching Tool Carrier
5. Ammunition Case
6. Canteen Pouch
7. First Aid/Compass Pouch
8. Sleeping Bag Carrier

[1] M-1956 Load-Carrying Equipment
[2] M-1956 Load-Carrying Equipment



M-1961[1]

All components were made of cotton canvas webbing, and utilized slide-clip fasteners and hooks to attach to the belt. The belt consisted of metal tab closures and three rows of metal ring holes to allow older M-1928 gear to work in conjunction with new M-1961 gear. The suspenders came in three sizes: regular, long and extra-long. These were hooked into the holes on the belt, and provided some personalization for troop comfort. The field pack, also known as the "butt pack", was altered from the M-1956 version by providing additional rings on the bottom of the pouch and modifying the shape of the top flap to a skirt shape, as opposed to the previous rectangular-shaped flap. The M-1961 system could be worn by itself, or in conjunction with the Tropical Rucksack.

[1] M-1956 Load-Carrying Equipment

Tropical Rucksack Major Components:[1]

1. Main storage space
2. Three external pouches
3. Waterproof liners
4. External frame, X-shaped
5. Straps
    - -Buckles- external pouches
    - -Adjustable straps- main storage space
    - -Shoulder straps- adjustable
6. Padding
    - -Shoulder strap padding
    - -Belt-line padding

M-1961[1]

[1] Tropical Rucksack

2.1.2.3 Military Service

The M-1961 was developed for use by the Marine Corps, but was eventually utilized by the Army for a brief period of time during the early parts of Vietnam. Some of the issues with water-proofing were resolved, but issues continued to arise due to the harsh operating environment forces were acting in. The additional storage space provided by the Tropical Rucksack, and functionality with the M-1961 system, was largely welcomed compared to the M-1928 system. Complaints with weight distribution continued to arise, and would be addressed with the ALICE system developed later on during Vietnam.

2.2 All-purpose Lightweight Individual Carrying Equipment (ALICE)

ALICE in use[1]

2.2.1 Development

The ALICE pack is the result of the Lightweight Individual Clothing And Equipment (LINCOLE) program, which officially began in 1965 and was intended to lighten the combat soldier's overall load.[2] This program was established to develop lightweight equipment suited to the style of war being fought in Southeast Asia. Natick Laboratories was contracted to design this new system.

[1] Alice load carrying equipment
[2] Alice load carrying equipment

In Vietnam, combat soldiers operated in smaller units, dense jungles, and for a longer period of time than previous combat operations in WWII and Korea. The terrain and warfare style forced soldiers to carry all supplies and equipment on their person. Resupply was difficult and not ideal while conducting combat operations against an intelligent and ruthless enemy.

In 1961, a lightweight rucksack was developed which replaced canvas and steel with aluminum and nylon. This use of lightweight, durable materials reduced the packs weight from 7.5 to 3 pounds.[1] This weight reduction of fifty percent set the precedent for the design of the ALICE pack system in the near future.

LINCOLE engineers decided that the design for the new load-carrying equipment would follow that of the standard load-carrying equipment. Material changes would include cotton canvas duck to nylon duck, and replacement of the brass and steel hardware with aluminum or plastic items.

The design of the ALICE pack went slowly due to the difficult task of creating a pack that could withstand the jungle environment of Vietnam, while enduring the abuse of combat operations. Initial analysis showed that replacing current pack components was not feasible, due to monetary and operational constraints.[1] Natick Laboratories suggested several options for redesigning and adopting a whole new load-carrying system. Eventually the M-1967 Modernized Load-Carrying Equipment was adopted, but the field pack for the system was rejected.[1] The United States military chose to keep the current M-1961 Tropical Rucksack in

[1] All-purpose lightweight individual carrying equipment

service instead. They chose this option because the newly proposed rucksack was extremely similar to the current model being used.

The LINCOLE program continued to develop and refine a lightweight load-carrying system. In July 1969 a board called the Infantry Team was formed, comprised of several Army Commanding Generals.[1] This board met to discuss the improvement of infantry clothing and equipment, and a representative from the Natick Laboratories LINCOLE program was invited to attend this meeting. The result of this meeting was the formation of another board, made up of all Non-commissioned Officers (NCOs).[1] Non-commissioned Officers are the backbone of the United States Military; they are the men that ensure tasks are run efficiently and are accomplished. This board was formed to obtain the opinion of men who have proven their worth in the military and have been in harsh environments and combat with the gear they were trying to improve. This NCO board noted many characteristics they felt were desirable, and suggested many improvements to the current Load-Carry System. In December 1969 all testing was halted for reevaluation, due to the suggestions by the NCO board.[1] The Infantry Team and the NCO board provided many recommendations to improve the Load-Carrying system. However, only one recommendation was given for the field pack: to make an improved version of the small and large field pack and field pack frame.

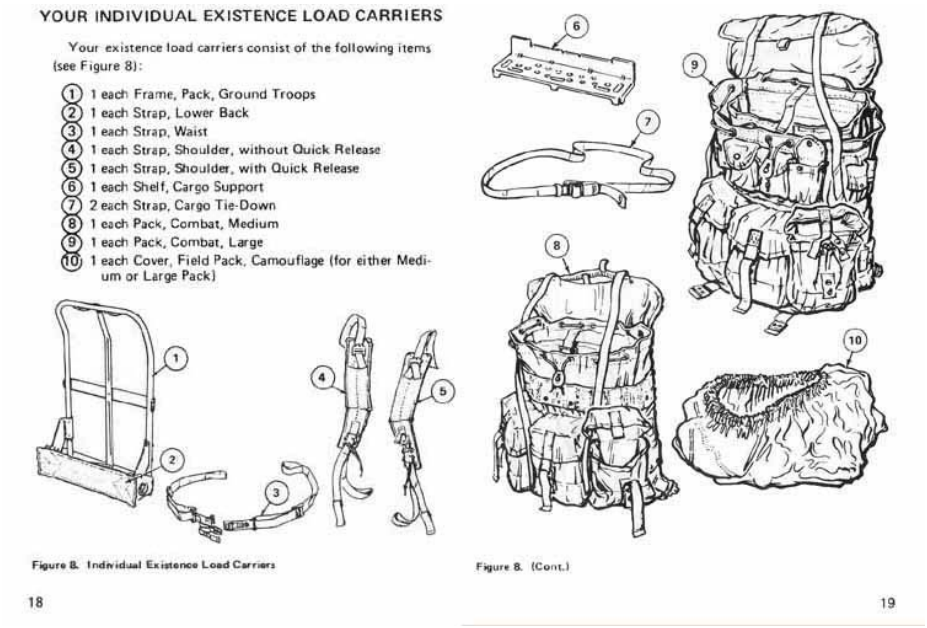
These recommendations lead to the adoption of a third field pack. This medium pack was added to meet the NCO board's requirements for an additional small field pack without a frame. Testing yielded many deficiencies with the initial design. Natick Laboratories corrected

[1] Alice load carrying equipment

these problems and after final testing the All-purpose Lightweight Individual Carrying Equipment was officially put into service on January 17, 1973.[1]

2.2.2 Specifications

The ALICE System retains the concept of fighting and existence loads. Figure 4 is a page from the ALICE System instruction manual.



YOUR INDIVIDUAL EXISTENCE LOAD CARRIERS

Your existence load carriers consist of the following items (see Figure 8):

1. 1 each Frame, Pack, Ground Troops
2. 1 each Strap, Lower Back
3. 1 each Strap, Waist
4. 1 each Strap, Shoulder, without Quick Release
5. 1 each Strap, Shoulder, with Quick Release
6. 1 each Shelf, Cargo Support
7. 2 each Strap, Cargo Tie-Down
8. 1 each Pack, Combat, Medium
9. 1 each Pack, Combat, Large
10. 1 each Cover, Field Pack, Camouflage (for either Medium or Large Pack)

Figure 8. Individual Existence Load Carriers

Figure 8. (Cont.)

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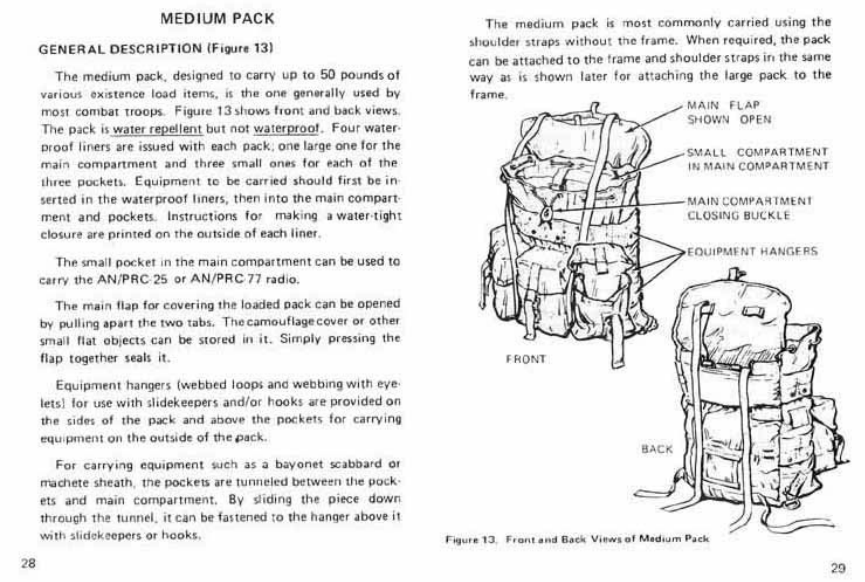
Figure 4: ***Alice Pack System***[2]

Major Components:

Field Pack (medium) – "*The field pack is designed to carry up to 50 pounds of existence load items and is made of water repellent treated nylon duck and webbing, spacer fabric, and metal hardware. The main compartment closes by means of a drawstring secured by a plastic cord clamp. A radio pocket is located against the back on the inside. The size of the pack may be decreased for smaller loads by means of three para-cord ties, stitched to the inside bottom of the pack, and three metal D-rings located directly below the internal radio pocket. Three pockets on*

[1] Alice load carrying equipment
[2] All-purpose lightweight individual carrying equipment

the outside, with strap and buckle adjustable closures and with snap fasteners for quick access, are provided for miscellaneous items. The top flap has a pocket with a hook and pile fastener tape sealed closure. Equipment hangers are located above each outside pocket and on each side. Drainage eyelets are provided in the bottom of the main compartment and the outside pockets. An envelope pocket is located at the top, back of the pack and padded with spacer cloth, into which the field pack frame is inserted when the field pack is used on the field pack frame. Buckles and straps at each side near the bottom are used for anchoring the field pack to the field pack frame. Two rectangular wire loops located at the top back of the field pack and D rings on each side at the bottom of the field pack are used to provide shoulder strap attachment when the field pack is carried without the field pack frame. A waterproof bag is supplied for the main compartment and each of the three outside pockets for keeping equipment dry. Figure # is a description of the medium pack from the ALICE system instruction manual.[1]"



MEDIUM PACK

GENERAL DESCRIPTION (Figure 13)

The medium pack, designed to carry up to 50 pounds of various existence load items, is the one generally used by most combat troops. Figure 13 shows front and back views. The pack is water repellent but not waterproof. Four waterproof liners are issued with each pack; one large one for the main compartment and three small ones for each of the three pockets. Equipment to be carried should first be inserted in the waterproof liners, then into the main compartment and pockets. Instructions for making a water-tight closure are printed on the outside of each liner.

The small pocket in the main compartment can be used to carry the AN/PRC-25 or AN/PRC-77 radio.

The main flap for covering the loaded pack can be opened by pulling apart the two tabs. The camouflage cover or other small flat objects can be stored in it. Simply pressing the flap together seals it.

Equipment hangers (webbed loops and webbing with eyelets) for use with slidekeepers and/or hooks are provided on the sides of the pack and above the pockets for carrying equipment on the outside of the pack.

For carrying equipment such as a bayonet scabbard or machete sheath, the pockets are tunneled between the pockets and main compartment. By sliding the piece down through the tunnel, it can be fastened to the hanger above it with slidekeepers or hooks.

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The medium pack is most commonly carried using the shoulder straps without the frame. When required, the pack can be attached to the frame and shoulder straps in the same way as is shown later for attaching the large pack to the frame.

MAIN FLAP SHOWN OPEN
SMALL COMPARTMENT IN MAIN COMPARTMENT
MAIN COMPARTMENT CLOSING BUCKLE
EQUIPMENT HANGERS
FRONT
BACK

Figure 13. Front and Back Views of Medium Pack

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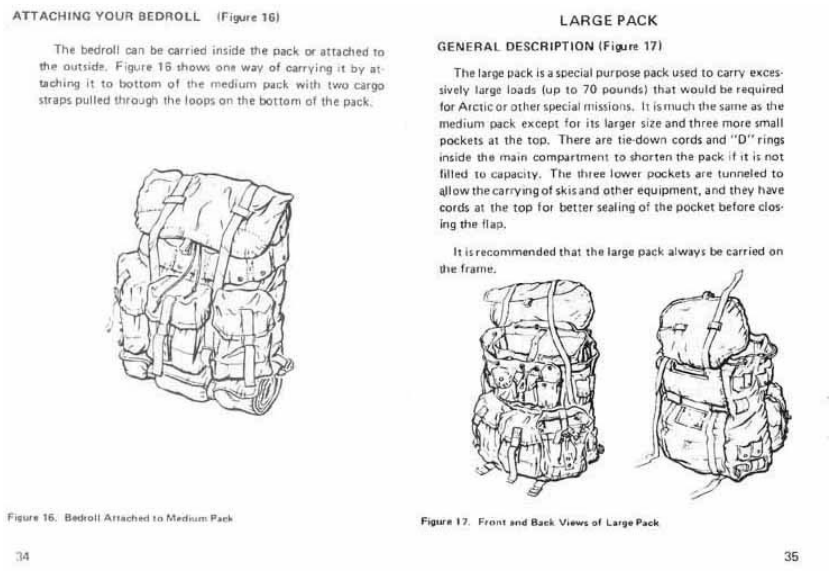
Figure 5: ***Medium ALICE Pack***[2]

Large Field Pack- The construction and materials in the large field pack are similar to the medium field pack. Key differences are increased size and the addition of three small outside pockets.

[1] Rottman, G.
[2] All-purpose lightweight individual carrying equipment



ATTACHING YOUR BEDROLL (Figure 16)

The bedroll can be carried inside the pack or attached to the outside. Figure 16 shows one way of carrying it by attaching it to bottom of the medium pack with two cargo straps pulled through the loops on the bottom of the pack.

Figure 16. Bedroll Attached to Medium Pack

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LARGE PACK

GENERAL DESCRIPTION (Figure 17)

The large pack is a special purpose pack used to carry excessively large loads (up to 70 pounds) that would be required for Arctic or other special missions. It is much the same as the medium pack except for its larger size and three more small pockets at the top. There are tie-down cords and "D" rings inside the main compartment to shorten the pack if it is not filled to capacity. The three lower pockets are tunneled to allow the carrying of skis and other equipment, and they have cords at the top for better sealing of the pocket before closing the flap.

It is recommended that the large pack always be carried on the frame.

Figure 17. Front and Back Views of Large Pack

35

Figure 6: ***Large ALICE Pack***[1]

Field Pack Frame- The field pack frame is used as a mount for both the medium and large field pack. The frame is constructed with black aluminum tubes.

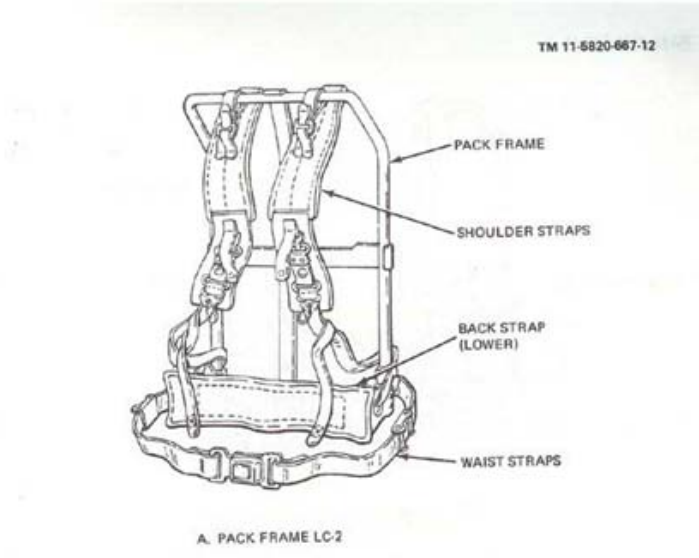

Figure 7: ***ALICE Pack Frame***[1]

[1] All-purpose lightweight individual carrying equipment

Minute Components:

"Cover, Field Pack - white
Strap, Webbing - M-1967 cargo strap
Strap, Webbing - lower back strap
Strap, Webbing - waist strap
Strap, Webbing - left shoulder strap with quick release
Strap, Webbing - right shoulder strap without quick release

Components introduced in 1977 as replacements:
Field Pack (medium) - with new buckles and no liners
Field Pack (large) - with new buckles and no liners
Frame, Field Pack - green metal
Strap, Webbing - lower back strap and waist strap
Strap, Webbing - frame attaching strap
Strap, Webbing - right shoulder strap with quick release "[2]

2.2.3 Military Service

Adopted in 1973, the ALICE pack remains in service today. The ALICE pack has been used by all U.S. armed forces during major conflicts over the past two decades. These conflicts include Operation Urgent Fury in Grenada, Operation Just Cause in Panama, and Operation Desert Shield and Desert Storm in the Gulf War. The ALICE pack is still used for training purposes by the United States Army and Marine Corps.

The ALICE pack was set to be replaced with the adoption of the Modular Lightweight Load-Carrying Equipment (MOLLE) in 1997, but remains in use today because it has no leave service date.[3] The popularity of the ALICE pack among Military Personnel has made the changeover to the MOLLE and Improved Load-Bearing Equipment (ILBE) slow. Military

[1] All-purpose lightweight individual carrying equipment
[2] Rottman, G.
[3] Alice load carrying equipment

Personnel continue to praise the ALICE pack for its simplicity and durability- two characteristics that the MOLLE does not possess.

On the other hand, the ALICE pack is a crude piece of equipment and not designed for great comfort. It is not molded to fit the back of the soldier and does not distribute the weight well. The following was stated by a former Navy SEAL, pertaining to the ALICE pack, "When you are on a five day mission with one hundred and twenty pounds in your pack, the ALICE pack doesn't fit well on your back, it rides low and beats on your kidneys. After two days I could see blood in my urine" (GMG1 Don Porter, USN, Retired).

U.S. Army Soldier in Iraq[1]

2.3 Modular Lightweight Load-carrying Equipment

The Modular Lightweight Load-carrying Equipment or MOLLE was introduced in 1997 as a replacement for the tried and tested All-purpose Lightweight Individual Carrying Equipment (ALICE). It did not see combat until 2001 when the United States became involved in Afghanistan. The MOLLE is designed to be a modular system. This allows for the individual soldier or marine to alter his pack based on mission. The requirements during the design phase were that it had to be durable, modular and comfortable.

[1] MOLLE Pack and Pouches

U.S. Marine wearing a MOLLE[1]

2.3.1 Development

Extensive research was put into creating a more ergonomic rucksack. The U.S. Army Research Institute of Environmental Medicine in Natick, Massachusetts assisted in conducting biomechanical studies directed at creating a more efficient pack. When comparing the ALICE to commercial off-the-shelf backpacks, it was found that the commercial pack was far more efficient at conserving energy. It was determined that the more vertical design allowed for a better distribution of weight over the pack and shoulders. It is important to note that the commercial pack used an internal frame while the ALICE uses an external frame.

Even though the commercial pack proved superior in efficiency to the ALICE, it was rejected because of its excessive heat retention. However the studies on pack volumes and weight distributions proved useful and were incorporated into the final MOLLE design. A plastic frame was developed at Natick labs with a material similar to the one used in car bumpers. This

[1] Modular MOLLE

allowed the frame to be contoured in a more anatomical manner. This plastic is a significant improvement from the ALICE pack which uses a frame made out of tubular aluminum. The new polymer was found to dramatically increase durability and successfully function at a variety of temperatures ranging from -40 to 120 degrees Fahrenheit.

2.3.2 Specifications

The main design feature of the MOLLE is an external frame that the auxiliary pouches can be fastened to. The pack can be tailored to several different infantry elements including Rifleman, grenadier, pistol, Squad Automatic Weapon gunner and medic. The MOLLE system consists of a load bearing vest with butt pack, a main rucksack with sustainment pouches and a sleeping bag compartment all connected to an external frame. The pack also has an attachable patrol pack. This smaller daypack can be used in conjunction with the main pack for additional storage or alone as an assault pack.

The Components of a United States Army MOLLE[1]

[1] $397.5M in contracts for MOLLE Backpacks, Veats et al.

The load bearing vest is the only part of the MOLLE system that is used at all times. This integral accessory has pouches that can carry ammunition and hand grenades. As mentioned earlier the rest of the pack can be used in as a completely modular system. The vest has several different configurations based on the member of the squad using it. This is useful because the pocket and pouch requirements of a field medic or corpsman do not match those of a machine gunner.

Fighting Load Carrier[1]

Unlike the ALICE the MOLLE was designed to fit both male and female frames. In order to deal with the many different body sizes of infantry soldiers a system of straps and pads has

[1] Modular MOLLE

been designed to help make the pack universal. The adjustable straps allow for soldiers to adjust the location of the pack while marching.

The MOLLE uses the Fighting Load Carrier (FLC) as a support frame. This replaces the older Load Bearing Equipment (LBE) used in the ALICE. The FLC is a major improvement on the LBE, instead of using suspenders and a web belt, the FLC is a single piece vest. This greatly increases the amount of ammunition that can be comfortably carried allowing soldiers to distribute the weight across their torso. One major improvement is that the vest has no metal hooks or loops that can often be uncomfortable and dig into skin. The high adjustability allows it to fit all sizes of infantrymen. It also allows the support belt to be fastened below it without hindering the user's mobility. There are three flap pockets distributed across the vest that are each capable of carrying two 30-round magazines. The vest also has pockets for two grenades and two canteen pouches.

MOLLE in use[1]

The rucksack has a bandolier capable of hold six additional 30-round magazines and a removable tactical radio pocket. The front of the pack has a pocket designed specifically for an M-18 Claymore Antipersonnel Mine. The pack also has detachable pockets to carry a sleeping bag and Meals Ready to Eat. The packs outside has D-rings that allow for carrying with a sling and two 6 foot straps for carrying large objects such as Motors or Mark 19 grenade launchers. The plastic buckles are all simply replaced if damaged or broken. A tube fed water bladder comes standard with the pack but is not rated for use when exposed to any forms of chemical or biological agents.

[1] MOLLE Pack and Pouches

Current models of the MOLLE use the Pouch Ladder System (PALS) to attach additional pockets. All packs developed since the MOLLE have used this system. It has been integrated into body armor as well, allowing for extremely customizable carried loads.

2.3.3 Combat Service

The MOLLE has seen combat in both Iraq and Afghanistan. The majority of its experience however has been in the mountainous terrain of Afghanistan. The pack was developed to be used by the USMC and was used through the early 2000s. It has since been adopted by the Army.

The Marine Corps used the MOLLE extensively in the early years of the war in Afghanistan. There were several major complaints that led to them dropping the pack in favor of the ILBE. Many reports came of zippers bursting when the packs had heavy loads. Another problem was with regards to the straps being too short to fit comfortably over Interceptor body armor. Another complaint was related to the durability of the external frame. The Army has since made changes to the pack including locking zippers and longer shoulder straps. Even with the changes to the pack the Marine Corps has phased it out in favor of the ILBE.

2.4 Improved Load-Bearing Equipment (ILBE)

2.4.1 Development

The United States Marine Corps (USMC) never became satisfied with the MOLLE pack. The MOLLE was complex to use, very cumbersome, and did not meet Marine Corps requirements for durability and reliability. After use in Iraq and Afghanistan, the MOLLE got poor reviews from soldiers in the field. The plastic frame broke relatively easily and the compartmentalization was a nightmare for infantrymen who were focusing on fighting the enemy and not their equipment.

The Marine Corps began to design a new pack that was going to be called the Improved Load-Bearing Equipment (ILBE) that was simple and durable like the ALICE pack and also took the best features from the MOLLE. The major areas of improvement desired from the MOLLE to the new pack were increased durability and comfort, reduced complexity and weight, and sustainability. More specific design features wanted was the ability of the pack to be able to carry 60mm mortar and 81mm mortar rounds outside the main pack, carry 120 pounds in gear, be no larger than 600 cubic inches, and have a detachable patrol pack. The Marine Corps wanted a pack that would be an aid to the lethality of the Marine in combat and not a burden. In 2003, the Marine Corps investigated two new pack designs. The selected designs were provided by commercial vendors Gregory and Arc'teryx.

The Arc’teryx design weighed “eight pounds four ounces and carried 5,000 cubic inches while the Gregory weighed nine pounds 10 ounces and carried 4,520 cubic inches.” Nine hundred models from both companies were sent to Marine units for field testing. The field testing was conducted from January to June 2003 and “biomechanical testing was conducted at U.S. Army Soldier Systems at Natick, MA who also compared the performance of the ILBE

candidates to the MOLLE system." On 15 January 2004 the Arc'teryx design based of their civilian Bora 95 pack was selected and set for production and direct replacement of the MOLLE. By March 2006, over 96,000 ILBE had been fielded. Currently, 238,000 ILBE packs have been supplied to active duty Marines plus additional packs for reservists.[1]

2.4.2 Specifications

The ILBE was designed by the Arc'teryx Law Enforcement and Armed forces (LEAF) program and manufactured by Propper Inc. The main goals of this pack were to provide comfort to Marines and be capable of carrying upwards of 120 pounds in gear.

ILBE[2]

[1] Strang, John
[2] USMC marpat ilbepack

Main Components:

Main sack- 4500 cu in.
Cordura 720 denier fabric
Assault pack- 1500 cu in.
Hydration system- 100 oz.
External side pockets
Zippered access to main pack, both sides
Zippered pouch in lid
Straps
    -Shoulder Strap
    -Sternum Strap
    -Hip belt
    -Compression straps- pulls pack closer to body
Extra padding in the shoulder straps and hip belt
Divider (optional) - can split the main sack into two compartments.
Internal Frame- lumber support, adjustable.

The pack provides space for a hydration system, and has a detachable assault pack on its exterior. The assault pack, in conjunction with the hydration system, is called the Assault Load Carrier (ALC) system. The ILBE pack also utilizes the Pouch Attachment Ladder System (PALS), technology developed for use with the MOLLE pack system. The PALS grid consists of rows of one-inch webbing that can be used to snap, hook and attach a variety of accessories. This flexibility has allowed many new accessories to be developed and easily integrated into use within the services, along with flexibility and ease of use for Soldiers and Marines.

The flexibility the ILBE provides has led to many variations of the pack being developed. The Reconnaissance ILBE system was developed for use by Marine Recon forces. This system has slight modifications from the Standard ILBE: 5500 cu in. main sack, 2300 cu in. assault pack, and two 500 in. external pouches. This additional space provides room to bring the extra equipment Recon Marines may be required to carry on certain missions, some that may require them be away from base for several days. The Corpsman Assault Pack (CAP) was developed for

use by Navy Corpsmen that work in conjunction with the Marine Corps, and is equivalent to the ALC used by the Marine Corps. This assault pack provides customized space for medicinal supplies, providing additional protection for delicate equipment and easy, rapid access to them.

2.4.3 Military Service

The ILBE has been in use in the Marine Corps for several years now, and has largely been a great success. It has been used during both Operation Iraqi Freedom and Operation Enduring Freedom. The extra padding in the shoulders and belt are extremely comfortable, and help with weight distribution throughout the body. Main complaints with the pack are that it pulls away from the body, shoulder straps can interfere with weapon firing, it stresses the neck, lower back, hips and knees, and that it doesn't integrate well with body armor. New developments in body armor have spurred interest in an upgrade to the ILBE system, or a new pack system altogether.

ILBE in use[1]

[1] Photo by Lance Cpl. Michael V. Walters (USMC)

Chapter 3: Evaluation of the Packs

3.1 Survey Description

As we began to approach the challenge of redesigning the pack used by infantry soldiers, we realized that we needed information from the people that actually carry the packs into combat. To solve this problem, we designed a survey to hand out to active duty military personnel. Our surveys were completed primarily by Marines in 2nd Marine Division.

The survey is designed to evaluate the three packs most recently used by the United States Armed forces. In order to better understand the strengths and weaknesses of each pack, we created eight categories that factor into a Soldier or Marine's combat effectiveness. By observing trends in the packs, we can more easily track the improvements that have been made in the designs over the last 25 years. Our eight categories are: Weight, Durability, Comfort, Weather Resistibility, Gear Accessibility, Weight Distribution, Mobility, and Compartmentalization. Each category has a rating system of 1 (poor) to 10 (excellent).

Weight is crucial to the improvement of any pack. The more weight that can be reduced in the pack, the more mobility a soldier is granted. The more the initial pack weight is reduced, the greater the reduction in overall load a soldier carries. This is particularly important when considering the USMC Warfighting doctrine, which is based on mobility and quick striking.

We next looked at the durability of the packs. A critical failure of the packs structure can render a marine unable to transport equipment. This greatly reduces the effectiveness of both the individual and the squad. In a combat situation, marines often carry equipment that is meant to be spread across several individuals. If one person is unable to transport essential equipment it must be distributed across the squad, decreasing the effectiveness of the entire group.

Comfort may seem like a trivial thing to be concerned with in combat but it improves the overall morale of the individual soldier. Low morale leads to decreased motivation, an obvious hindrance to any combat leader. Pack comfort is influenced most by the support system. If the frame does not ride in the proper position on the users back serious injury can occur.

The weather resistibility describes the packs ability to stand up to the elements. Since packs face many extreme conditions this needs to be considered. Frames are particularly susceptible to failure due to climate. Both polymers and metals become more and less brittle at different temperatures. The packs water resistance also should be considered especially as soldiers begin to carry more electronics to the battlefield.

Gear accessibility is the soldier's ability to gain access to the contents of his or her bag. It can be critical to the success of a fire fight for a soldier to be able to retrieve items from the pack in a small amount of time. This can be affected by the location of the pockets and zippers and by the design of the interior of the rucksack.

Weight Distribution can be tied in with the support system of the pack. One of the most common problems with packs is that if worn properly they do not distribute weight across the back. Instead the weight is focused onto the shoulders causing fatigue much faster. With packs that often weigh over 100 pounds, proper distribution of weight must be considered to be of high importance.

In all combat environments speed plays a crucial role. The ability to outmaneuver enemies gives soldiers an advantage that can mean life or death. If the pack decreases the mobility of the soldier or marine they can possibly loose the upper hand in an engagement.

Compartmentalization can help or hinder combat troops. The number and location of pockets in a ruck may help or hinder a marine during combat. The pockets must be located in a simple logical pattern making it simple to find equipment quickly.

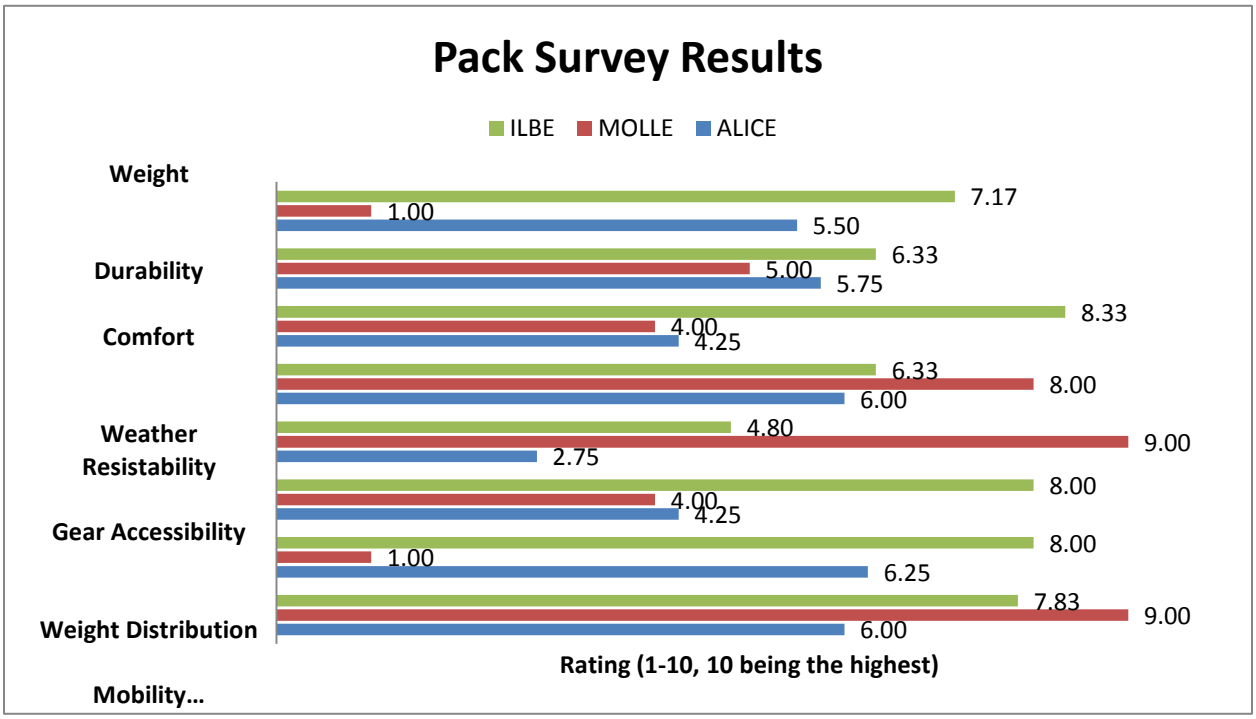

Figure 8: ***Pack Survey Results***

3.2 Modified Design Matrix

Below is a modified design matrix used to evaluate the three main packs of the modern era. A design matrix is used to analyze designs based on the needs of the user. In this case, the user is the individual who wears the pack. The data presented was compiled from the survey explained earlier. Each pack was scored in eight categories. The scores were weighted with respect to that category's overall contribution to the desirability of the pack. The weighted value of each category shows its relative importance to the overall usefulness of each pack. For eight parameters, the average value is 12.5 percent. In this table, the weighted values show little variation from the average indicating that all eight categories are of similar importance.

	Weight	Durability	Comfort	Weather Resistibility	Gear Accessibility	Weight Distribution	Mobility	Compartmentalization	Total
Value	0.11	0.14	0.14	0.11	0.12	0.14	0.13	0.11	1
ALICE	6.00	6.25	4.25	2.75	6.00	4.25	5.75	5.50	5.1
MOLLE	9.00	1.00	4.00	9.00	8.00	4.00	5.00	1.00	4.96
ILBE	7.83	8.00	8.00	4.80	6.33	8.33	6.33	7.17	7.168

Figure 9: ***Modified Design Matrix***

The categories ranked from most to least important are; weight distribution, comfort, durability, mobility, gear accessibility, weight, compartmentalization, and weather resistibility. We decided that weight distribution and comfort are the most important because of their effect on the individual Marine. These attributes may affect both the mental and physical wellbeing of individual Marines. This degrades the morale of infantrymen and has a negative impact on their combat effectiveness. Durability was considered one of the most important categories because of the conditions the pack will be used in. Unlike civilian backpacking packs, any military pack must be able to withstand the material stresses resulting from combat operations. Marines cannot risk critical pack failure during combat missions.

For our design matrix, mobility and gear accessibility were deemed of similar importance to each other. Mobility is a soldier's ability to maintain a suitable range of motion while wearing the pack. Though mobility does affect the comfort of the individual, it is its own category because it also has a direct influence on combat effectiveness. Although Marines do not usually fight with a pack on, mobility is still needed in case of emergencies. Gear accessibility is not directly related to overloading the troops, but it is important to keep in mind because of its affect on Marine's combat effectiveness. Soldiers need to have an easy way to gain access to their equipment during fire fights or any other life threatening situation.

We judged compartmentalization, weight, and weather resistibility of less importance to the pack than the previous categories because they do not significantly affect combat effectiveness. Because of this we assigned lower waited values to these three categories. Compartmentalization, though similar to gear accessibility, deserves its own category because it limits the equipment that can be carried by the pack. If a pack is too compartmentalized large items are unable to be carried, drastically limiting the pack's versatility. The weight category is referring to the actual weight of the pack while unloaded. There is a Marine Corps saying, "ounces equal pounds, pounds equal pain," meaning that even ounces will add up and poorly affect the individual troop. However, the weight when compared to a loaded pack is relatively small. It is for this reason weight was determined a less important category. Finally, weather resistibility is important because it helps with the versatility of the pack. Rain and water can add unnecessary weight to the pack if gear gets waterlogged. Weather resistance is not as important as the other categories are because the gear can be individually weatherproofed with plastic bags or using other techniques.

3.3 Analyzing the Design Matrix Results

The results from our modified design matrix show that the ILBE is superior to the other two packs. The ILBE made substantial improvements in the categories of weight distribution, comfort, and durability. Much of this is due to the change in shape and support system of the pack. The ILBE has an internal frame and much more padding on the straps along with a more robust waist strap that allows the load to be lifted off of the shoulders and distributed to the waist and core. The ALICE and MOLLE have similar designs. Both use an external frame, and are more compact packs. This leads to discomfort when carrying them due to the poor weight

distribution. The durability of the MOLLE pack is not rated highly as a result of the external frame being made from a plastic that has been known to break under stress.

In the categories of gear accessibility and mobility, the ILBE does not outperform its fellow packs. The MOLLE was designed with gear accessibility in mind. Its modular design is adaptable and allows every piece of gear to have a spot in the pack. This design makes the pack larger and due to its shape limits the mobility. The ALICE pack, on the other hand, is a small pack, which allows good mobility. However, its mobility is limited due to the way it rides on the back of the Marine. The ALICE has only one large pocket and three smaller outer pockets. This makes it difficult to access gear if it is not packed at the top of one of the pouches. The ILBE is a larger pack than the ALICE and has the assault pack detachment which helps improve its mobility. Even when the ILBE is fully loaded, the Marine's mobility is relatively high. Gear in the ILBE is more difficult to access then the MOLLE, but it has a separate assault pack and side pouches that allow gear to be packed efficiently allowing easy access. The main compartment of the ILBE is large and especially tall which leads to problems if important gear has been placed at the bottom of the pack. The ILBE does have side zippers that allow access to the equipment stored in the bottom of the pack. When they are used it is tough to keep the things inside the pack when all the gear is packed tightly.

The MOLLE outperformed the ALICE and ILBE in the last three categories. Its weather resistibility and weight are rated very highly, but its compartmentalization was rated very low. The weight is rated so highly due to the fact the frame is made from a lightweight plastic. Traditionally the frame is where most of the weight of the pack comes from. Though designed with compartmentalization in mind, the many pockets cause trouble because it is difficult to find equipment. The ALICE and ILBE had similar trends to each other, both performing slightly

above average in both compartmentalization and weight, but well below average in weather resistibility. The ILBE outperformed the ALICE, but the trends were the same. The poor weather resistibility is due to the material selected for the main pack. Just a thin layer of material is between all the stored equipment and the exterior of the pack.

Overall the matrix showed that that the ILBE is the most well rounded pack of the three. Its design allowed it to perform consistently well in all the categories and especially well in the categories that we chose to be most important to the overloading issue. The ALICE performed consistently throughout the survey, which is impressive considering its age. It should be used as a comparative reference tool when designing future packs. The MOLLE, though a unique idea with its modular design, has too many weaknesses to continue its production. The modular pack concept should still be addressed when designing packs.

Chapter 4: The Future of the Pack

4.1 Needs of the Marine Corps

This chapter is the culmination of our report. To come to the conclusions that are made in this chapter we researched the history of all Marine Corps packs since 1928 and analyzed their strengths, weaknesses, and effectiveness on combat missions. During our research we found out why packs were replaced or improved upon, which helped us understand what the Marine Corps is looking for in future packs. The current pack used by the Marine Corps, the Improved Load Bearing Equipment (ILBE), possesses many of the qualities that have been required in Marine packs since the Vietnam era. It is lightweight, durable, and can carry a large load. However, it still has many shortcomings and one major downfall. This is why the Marine Corps is already in the process of looking for solutions to modify or replace the ILBE.

The ILBE was introduced in 2004, before improvised explosive devices (IEDs) became a major concern in Iraq and Afghanistan. IED attacks have become frequent and widespread since then, and now cause the majority of American casualties. This problem resulted in the design of a new stronger and heavier body armor system called the Modular Tactical Vest (MTV), introduced in 2007.[1]

[1] Curtis, R., and A. McCullough

Modular Tactical Vest[1] *Marines on patrol in Afghanistan using the MTV and ILBE*[2]

After a survey issued in the summer of 2009, and further testing, the Marine Corps discovered the new MTV does not integrate well with the ILBE. The survey tested approximately 770 combat-proven Marines.[3] The exact details of the survey were restricted because it they are considered "acquisition sensitive material."[1] The main reason that the IBLE does not integrate well with the ILBE, and the Marine Corps decided to begin looking for a replacement, is that the back Small-Arms Protective Insert plate (SAPI), which is a ceramic bulletproof plate, is curved from side to side while the back of the ILBE is flat.[1] This creates a single edge of contact between the two systems, causing the weight of the pack to be pulled away from the Marine's upper body. The ILBE's support system was designed to create one plane of contact between the user and the pack, drawing the weight closer to the user's center of gravity and evenly distributing it across his back. This single edge of contact is not compatible with the design of the ILBE's support system and renders it useless. Many medical issues have arose from this poor integration such as straining in the neck, back, knees and hips, as well as high amounts of chaffing. In late 2008 the 2nd Battalion, 7th Marines returned from a tour in

[1] www.body-armor.com/images/mtv.gif
[2] www2.tbo.com/.../5436_marines-in-afghanistan.jpg
[3] Curtis, R., and A. McCullough

Afghanistan where nearly 70 percent of their combat patrols were conducted on foot.[1] During these patrols they always wore MTVs and carried ILBEs the majority of the time. This case demonstrated integration problem with the pack and vest. Upon their return, a post-deployment health examination was administered to its 786 members. Nearly one third of the battalion reported back pain and a quarter experienced problems in their joints.[1]

Small-Arms Protective Plates[1]

After analyzing the issues caused by this integration problem the Marine Corps announced that the ILBE was "completely unacceptable."[2] The Marine Corps determined that it was necessary to replace the ILBE instead of the MTV because the MTV provides Marines with additional protection which may save lives. Additionally, it was determined to be more cost effective to replace or modify the ILBE.

Another major problem with the ILBE is that the thick shoulder straps restrict Marine's ability to engage their weapons.[1] This limits their capability to react during life threatening situations, which they frequently face. Considering the ILBE is designed to be used in combat, this is entirely unacceptable.

[1] 2.bp.blogspot.com/.../s400/800px-Sapi_plates.jpg
[2] Curtis, R., and A. McCullough

The Marine Corps announced requirements for a new pack system in late 2009 that are not drastically different from what the ILBE brings to the table.[1] The major difference is that it must have an adjustable suspension system, so that that the pack can be tightened to the Marine's back whether he is wearing body armor or not. Although the Marine Corps is looking for a new pack, they have not ruled out modifying the ILBE so that it integrates better with the MTV.

The Marine Corps held an industry day on 22 January 2010 to allow commercial vendors from across the country to demonstrate their products and to address the shortcoming of the ILBE.[1] Four possible replacements packs were shown, three are already in service:

4.1 Mystery Ranch's TactiPlane

The Tactiplane pack is currently in service with the U.S. Special Operations Command (SOCOM), and is used for extended missions. The characteristic of the pack that makes it so desirable to the Marine Corps is that it has proven to integrate well with body armor. It incorporates a Modified Cush Lumbar Wrap, which wraps the pack over the back of the body armor.[2] This holds it tight to the users back and creates one complete plane of contact, unlike the ILBE. Among other strengths, it can carry a load surpassing 100 pounds and has a unique system of zippers that enables you to access gear deep in your pack without having to take everything out.[2] Also, the upper frame has been designed for maximum head movement, so even with a helmet on and in the prone position you can effectively engage enemy hostiles. The specifications of the pack are listed below, and the detailed information from the manufacturer is included in the appendices:

[1] Curtis, R., and A. McCullough
[2] "Mystery Ranch." *Tactiplane*

Weight: 9 lbs 10 oz

Volume: 6000 cu-in

Dimensions: 34.5"x16"x14.5"[2]

Tactiplane- Front View[1]

Tactiplane-Back View[1]

4.2 Mystery Ranch's Wolfpack with NICE frame

The Wolfpack is similar to the Tactiplane and is intended to be used on extended missions or backpack hunts. The major difference is that it has a NICE (Nylinear Individual Carrying Equipment) frame.[2] The NICE frame flexes with your body, but does not sag when loaded.[2] It is also designed to provide more support when being worn over body armor, a highly

[1] "Mystery Ranch." *Tactiplane*
[2] "Mystery Ranch." *NICE Wolfpack*

desirable trait for the Marine Corps. The Wolfpack can also be setup in many configurations. It consists of two bags; the Alpha bag and the Pup bag, which have a carrying capacity of 4200 and 1900 cubic inches respectively.[2] The basic specifications are listed below:

Volume: 6100 cu-in

Weight: 9 lbs 4 oz

Dimensions: 23"x13.5"x9"[1]

Wolfpack- Complete setup[2]

Wolfpack- Broken Down[3]

[1] "Mystery Ranch." *NICE Wolfpack*
[2] "Mystery Ranch." *NICE Wolfpack*
[3] "Mystery Ranch." *NICE Wolfpack*

4.3 Granite Gear: CHIEF (Composite Hybrid Interchangeable Ergonomic Framesheet)

The pack proposed by Granite Gear is a larger version of the patrol pack currently fielded by U.S. Special Operations Forces. Granite Gear mainly manufactures civilian equipment, but has an excellent reputation designing lightweight packs. The CHIEF recce pack has removable shoulder-strap padding that gives soldiers better flexibility while wearing body armor[1]. It also rides very low for such a large pack, allowing decent helmet clearance while standing or prone.[2] "It also has an internal radio pocket, a bottom-exiting hydration port arrangement, top-mounted haul loops and offers top or front access."[2] Not many details are available about the larger version proposed for the Marine Corps, but it has promised enough improvements to be considered in the top four packs.

[1] "Military Times." *Granite Tactial Gear Wins With CHIEF Patrol*
[2] "Military Times." *Granite Tactial Gear Wins With CHIEF Patrol*

Granite Gear- CHIEF[1]

4.4 Improved MOLLE

The improved MOLLE is a much different version than the Marine Corps previously used. The most appealing quality that this improved version possesses is that it integrates well with body armor. Also, the frame has been reinforced and is no longer prone to cracking.[2] Quick release straps have been incorporated so that soldiers can shed their packs quicker in a firefight.[2] Another desirable characteristic of the MOLLE is that it is wider than the ILBE. The height of the ILBE restricts Marines from lifting their head's to engage the enemy while lying in the prone position. It usually has to be shed to return fire effectively- this problem is not so prevalent in the MOLLE. Many of the shortcomings of the original version have been corrected, but some, such as the complex compartmentalization, still remain.

Improved MOLLE being used in Afghanistan[3]

[1] "Military Times." *Granite Tactial Gear Wins With CHIEF Patrol*
[2] Curtis, R., and A. McCullough
[3] http://www.army.mil/-images/2009/10/15/53331/army.mil-53331-2009-10-16-121046.jpg

The Marine Corps announced that they are considering all options, from "going with an Army design, to going with a whole new pack, to re-engineering the ILBE."[1] They will begin testing prototypes in the summer of 2010. These packs all present solutions to the current problem with body armor integration that the Marine Corps is currently dealing with. However, none of them are without weaknesses or have areas that cannot be improved upon. There are additional features that can be added to make them more dynamic, and service the individual Marine better.

In our research we have found several areas which the ILBE is deficient and can be improved upon, as well as additional features that could be added to it, or a future pack, to make it more dynamic. We have divided these recommendations into two categories. The first category is short term improvements that could be immediately fixed without replacing the pack entirely. The main short term improvement we are suggesting is the redesign and adoption of an adjustable suspension system. Other short term recommendations are increasing water resistibility and incorporating a hydration bladder into the pack. The second category is long term improvements, which is ultimately taking all the positive qualities of the ILBE, our short term recommendations, and additional recommendations for improvements that could not be incorporated without complete redesign and making a whole new pack. These improvements that would be included in the design of a new pack are adding a water sterilization system, a flotation-system to make the pack buoyant, and possible material changes. All these improvements are intended to give the individual Marine an additional tactical advantage.

[1] Curtis, R., and A. McCullough

4.2 Short -Term Recommendations

4.2.1 Shoulder Suspension System

In our research we have determined that the only way the Marine Corps is going to keep the ILBE in service, is if the integration problem between the pack and the Modular Tactical Vest is solved. The only way to solve this problem is to create a new shoulder suspension system that allows the ILBE to fit tightly to the users back; whether he is wearing body armor or not. This new system needs to allow the pack and the MTV to have one plane of contact in order to evenly distribute the load across the user's back and keep it closer to his center of gravity. Providing a secure fit, close to the user's body, is essential so that no unnecessary stresses are created. This can be accomplished by developing a design to make the back of the ILBE meet the contour of the SAPI plate. It needs to be adjustable so that it can always be adapted to fit tight to the user whether body armor is being worn or not. This immediate need of the Marine Corps makes creating a new shoulder suspension system our most important short term recommendation. If an effective system is not created to solve this problem then the ILBE will be replace, rendering all of our other short term recommendations useless. It would also be much more feasible to modify the current pack to solve its one major flaw, instead of adopting a whole new one.

4.2.2 Detachable Hood/Rain Cover/Hydration Bladder

The current ILBE design has a detachable pouch on the top that is designed to cover the top of the pack and also has space for storage. This pouch is the same material as the rest of the pack and is not intended to be waterproof. We recommend replacing this current pouch with a new one made of waterproof material. This pouch, in effect, will act as an umbrella shielding the rest of the pact. This is not intended to completely waterproof the pack, but it will provide additional protection to keep gear dry.

ILBE[1]

Some hiking packs used by civilians feature a pull-out rain cover. This rain cover is connected to the pack and rolled into a pocket. When needed it can be rolled out and then pulled over the entire pack to help keep it dry. We recommend incorporating this feature into the new waterproof cover. In order to incorporate this idea onto military packs the rain cover needs to be made out of a durable material to meet Marine Corps standards. Over time, the rain fly may tear and need to be replaced. To simplify replacing rain flies, they will be detachable from the pouch.

[1] http://www.military-backpacks.com/images/2009/04/ilbe-backpack.jpg

Rain Cover[1]

Another recommendation is to make a spot for a hydration bladder in the new top pouch. Currently, the ILBE system only provides room for a hydration bladder in the assault pack. This will give the user the option to either carry his water in the assault pack or in ILBE. Also, this gives him the option to carry two hydration bladders.

4.2.3 Conclusion

All these recommendations that we have made add weight to the overall load that the individual Marine has to carry into combat. Though adding additional weight does hinder Marines' combat effectiveness, the benefits these improvements provide outweigh the negatives.

[1] http://soldiersystems.net/blog1/wp-content/uploads/2009/05/down_east_pack_4-223x300.jpg

4.3 Long Term Recommendations:

Our long term recommendations are not intended for a specific pack model. They take the good qualities of all the packs previously used by the Marine Corps, along with new ideas that will make the pack more dynamic and effective. These new ideas that we suggest are improvements that could not be implemented unless a whole new pack is designed.

The next generation pack should keep the following qualities of the ILBE: tool loops, hydration bladder compatibility, sleeping system attachment, lumbar support, compression straps, and a side zipper. The tool loops are a system that allows all different types of gear and equipment to be attached without adding much weight or detracting from mobility. Hydration bladder compatibility could be improved by designing a built in hydration bladder, but either way hydration is key to troop welfare and combat effectiveness. The sleeping system attachment allows for easy placement of one of the more cumbersome items that needs to be carried for extended missions. The lumbar support and compression straps help support the spine and prevent injuries by keeping the back in the proper shape and pulling the weight closer to the body. Lastly the side zipper should be kept to allow for gear accessibility in the main pouch of the future pack.

As described in the previous paragraph the lumbar support of the ILBE is an important feature to keep, but the system currently employed could be improved. Currently the support is a solid piece that is similar to the shape of the average person's spine. However, every person is different and one way to change the lumbar and spinal support is to use a spring-like design. This keeps the pack from making direct contact with the back, which will lead to a more comfortable posture of the pack. The system is best utilized with a mesh back. The mesh back

allows for air ventilation between the pack and the user, while also acting as the spring because of its ability to stretch out. Mesh is very light and would decrease the weight of the unloaded pack because there would no longer be a need for the current lumbar support, which is not made of mesh and therefore heavier. The mesh would be supported by an extension of the frame and would make it so that none of the frame contacts the lower back of the user and, which improves support, comfort, and overall usefulness of the pack.

When Marines are on missions for extended periods of time the uniform get sweaty, wet, and dirty. Putting wet clothes back into a pack causes other items to get wet and does not allow them to dry and become usable again. A mesh pocket should be added to the outside of the pack so that wet clothing can air out and dry. This will provide the Marine with more comfortable and combat effective gear when he has to use it again on long combat operations.

Hydration is essential to mission accomplishment, so having a hydration bladder built into the next generation pack is a necessity. However, is just a hydration bladder good enough? Missions go on for days at a time and to carry the necessary amount water would puts a great strain on Marines and causes overloading. There are different technologies for water filtration systems available that include solar filters and old fashioned purifying filters. All of the current water filtration systems are small and would be easily integrated into the hydration bladder to allow a Marine to purify water in the field. This would help prevent overloading by not having to carry enough water to last for several days.

Another recommendation for improvement of the ILBE is water proofing and making the pack more weather resistant. The current pack has no serious measures built in that will keep the weather from destroying a Marine's personal and mission essential gear. Not having a device or

system in place to prevent this is an unacceptable oversight and it should be integrated into the next generation of pack.

The most efficient way of making a pack water proof would be to make it one big pouch and have that pouch completely sealed. However this is not a very practical design because of the need for gear accessibility and compartmentalization of the pack. The good qualities of a pack such as multiple pouches and a zipper down the side for accessibility can also be incorporated into the design.

Marine Compression ILBE PackLiner[1]

The Marine Corps has a system in place that is separate from the pack. It is pictured above and is a large waterproof pouch that seals tightly on the top that is designed to fit inside the pack. This is the most efficient to immediately address the waterproofing problem, but it deters from all the other qualities of the pack making it impractical. Also it is not included in the pack, so it is an extra item to carry. The next generation pack should have this waterproofing system built directly into the main pouch and all the secondary pouches on the outside of it. The

[1] http://soldiersystems.net/blog1/wp-content/uploads/2008/06/ilbe_bags_a.thumbnail.jpg

material used in this pouch is waterproof and does not have the same durability as the material used now, but it can be used as a liner. It is flexible and can be designed in any shape and it is thin and light so that adding it as a liner will not detract from the volume of space in the pouches or add much to the packs unloaded weight. Also a waterproof zipper can be placed on the side of the pouch, which allows gear accessibility while not removing the packs waterproof capacity. This liner does can also be placed into the smaller pouches. The only part that would need to be changed is the way the pouched seal. They would need to be designed with the same seal as the pouches that are pictured below. The system is an open top bag made of waterproof material that is rolled down 2-3 times and then curled so that the buckles cause the material to seal against itself.

Compression Sack Seal[1]

Another feature we recommend incorporating into the next generation pack is flotation. Water proofing is intended to improve the weather resistibility, but if the Marine needs to cross a river it is just as important to have a water proof pack. Currently it is extremely difficult to get gear across a river or body of water. By having a waterproof and buoyant pack the problem is not solved, but simplified. These packs weigh between 80-120 pounds on average, which is a a lot of weight to make float for such a small object. The goal of our recommendation isn't

[1] http://www.seatosummit.com/images/products/evacdry.jpg

necessarily to give the pack positive buoyancy, but to make the pack as close to neutral buoyancy as possible. The system put into place to make the pack waterproof is working for both these improvements because it will help with the displacement of water and therefore increase the buoyancy of the pack.

This system is not going to make the pack neutrally buoyant by itself, so it is necessary to add floatation devices to other parts of the pack. However, because of the weight it would add to the pack an entire system is not beneficial. Floatation devices or material would need to be added to areas of support system, where the pack contacts the body. By incorporating it this way it can be used as comfort and support while also adding to the buoyancy of the entire pack as a whole. It was decided that the best material to do this is the soft foam used in life preservers. Ideally this would replace the material used in the shoulder and waist straps. Also some additional padding would be added to the lumbar and spinal support structure. By adding material to the pack, weight will be increased. Due to the fact that the density of the foam is so small, the weight added will be negligible. Also the benefits of the added comfort and buoyancy will be more important to the overall versatility of the pack.

All of our recommendations are designed to give the individual Marine some advantage in order to make his extremely difficult, and dangerous, job a little easier. If these improvements are incorporated into the design of a new pack, they would improve its overall quality as well as make it more dynamic. We have ranked these improvements in the following order to illustrate which are greater in importance and should be considered before others: waterproofing/floatation, hydration filtration system, spring loaded/ mesh lumbar support, and lastly mesh outer pocket. Our prioritization of pack improvements is based upon what

improvements will give the Marine the greatest tactical advantage, therefore improving his overall combat effectiveness.

Bibliography

"$397.5M in Contracts for MOLLE Backpacks, Vests, et. al." *Defense Industry Daily - Military Purchasing News for Defense Procurement Managers and Contractors*. Web. 17 Dec. 2009. <http://www.defenseindustrydaily.com/3975m-in-contracts-for-molle-backpacks-vests-et-al-02526/#more>.

Alice load carrying equipment. (1998). <http://www.olive-drab.com/od_soldiers_gear_alice.php>

All-purpose lightweight individual carrying equipment. (n.d.). <http://www.georgia-outfitters.com/_alice/alicemanual.htm>

ARC'TERYX - Law Enforcement & Armed Forces. Web. 17 Dec. 2009. <http://leaf.arcteryx.com/>.

Clausewitz, Carl Von, and J. J. Graham. On War. [Miami, FL]: BN, 2007. Print

How to Pack the M-1928 Haversack. (2003). <http://www.hardscrabblefarm.com/ww2/m1928pack.htm>

Ilbe improved load bearing equipment. (1998). < http://www.olive-drab.com/od_soldiers_gear_ilbe_usmc.php>

M-1956 Load-Carrying Equipment. (1998). < http://www.olive-drab.com/od_soldiers_gear_m1956_webgear.php>

"Modular MOLLE." *Natick.army.mil*. Web. 17 Dec. 2009. <http://www.natick.army.mil/about/pao/pubs/warrior/01/sepoct/packitup.htm>.

"MOLLE PACK AND POUCHES." *MILITARY INFORMATION HQ*. Web. 17 Dec. 2009. <http://www.olive-drab.com/od_soldiers_gear_molle_pack.php>.

Pershings' Doughboys WWI U.S. Army Living History Group. (2003). <http://website.lineone.net/~hollis_wood/doughweb/equip.htm>

Strang, John. "Standard Individual Load Bearing Equipment." 19 Oct. 2009. Web. 20 Nov. 2009. <http://www.marcorsyscom.usmc.mil>.

The Infantryman's combat load. (1985). <http://www.globalsecurity.org/military/library/report/1985/IDC.htm >

Tropical Rucksack. (2005). <http://www.vietnamgear.com/kit.aspx?kit=453>

Tzu, Sun. *The Art of War (Barnes & Noble Classics)*. New York: Barnes & Noble Classics, 2004. Print.

United States Marine Corps. Marine Rifle Squad, MCWP 3-11.2. Washington, D.C.: Headquarters, U.S.Marine Corps, 2002.

United States Marine Corps. *Marine Corps Strategy (MCDP 1-1)*. New York: Wildside, 2006. Print.

United States Marine Corps. *Tactics (Marine Corps Doctrinal Publications MCDP 1.3)*. New York: Wildside, 2005. Print.

United States Marine Corps. *FMFM 6-4*. Washington DC: U.S. Government Printing Office. Print.

United States Marine Corps. *Warfighting (Marine Corps Doctrinal Publications MCDP 1)*. New York: Wildside, 2007. Print.

U.S. Army Rucksack of WWII. (1998). <http://www.olive-drab.com/od_soldiers_gear_mountain_rucksack.php>

US army long-range patrol scout in vietnam 1965-71 . (2008). <http://books.google.com/books?id=z3ppGmJHv48C&pg=PT24&lpg=PT24&dq=m1951+rucksack&source=bl&ots=n_hOsqA_zv&sig=c7W1x3b00Rftp3RjQuzvL5acg0s&hl=en&ei=BPUnS7P6GM_dlAfQ-vyRDQ&sa=X&oi=book_result&ct=result&resnum=7&ved=0CCcQ6AEwBg#v=onepage&q=m1951%20rucksack&f=false>

USMC marpat ilbepack. (2009). < http://ilbepack.com/>

WWII Packs: M-1928. (1998). <http://www.olive-drab.com/od_soldiers_gear_ww2pack_m1928.php>

WWII M-1928 Haversack Complete. (2001). <http://www.usmilitariaforum.com/forums/lofiversion/index.php/t1388.html>

Appendix A: Pack Surveys

Pack: I would like to premise this entire survey by saying that I have never used the MOLLE pack, and therefore my comparison will be between the ALICE and ILBE only.

ALICE MOLLE ILBE

s

Weight 1 2 3 4 5 6 7 8 9 10

Comments: As far as the weight of the actual pack is concerned, neither is prohibitively heavy. The metal frame on the ALICE pack does add a bit of weight, but it provides additional support that many Marines prefer, especially in the SOF community (RECON, MARSOC, etc).

Durability 1 2 3 4 5 6 7 8 9 10

Comments: Both the ILBE and the ALICE have durability issues. The ILBE has issues with the carrying handles, this concerns both the lifting handles, which are used to throw the pack overhead and the standard carrying handle. Both are simple pieces of cordura which have a tendency to rip at the seams when used to pick up a full pack (this can be rectified by reinforcing them with tubular nylon). The ALICE's main durability issue lies in its frame which is welded or riveted together, and when placed under stress has a tendency to break. While this structural failure usually doesn't occur until the pack has been used significantly, failure is usually catastrophic and leaves the pack completely unserviceable.

Comfort 1 2 3 4 5 6 7 8 9 10

Comments: Both packs have comfort issues, but this may simply be a function of the fact that there is no way to put 80-100 lbs on the back of a Marine comfortably. The ILBE was built as a civilian mountaineering pack by a company called Arc'Teryx and it shows, as a the pack is extremely comfortable when worn "slick" however, once a flak jacket is added (especially the Modular Tactical Vest (MTV) or the Scalable Plate Carrier (SPC)) it is awkward and uncomfortable. Primary comfort issues from the ALICE pack are due to the rigid frame which provides support but forces the load away from the body and creates a "lever arm" issue putting too much of the weight on the shoulders of the wearer.

Weather Resistibility 11 2 3 4 5 6 7 8 9 10

Comments: Neither pack provides significant waterproofing and the responsibility falls on the user to waterproof any contents in the pack.

Gear Accessibility 1 2 3 4 5 66 7 8 9 10

Comments: Both packs provide acceptable levels of gear accessibility. The external pockets on the ALICE pack allow for the user to pack gear that needs to be quickly accessible outside of the main compartment. The ILBE pack has an easily accessible top pouch that serves the same purposes, in addition to "sustainment pouches" which can be attached via MOLLE webbing to the exterior of the pack. Ultimately it falls on the user to pack his gear in an organized and compartmentalized manner.

Weight Distribution 1 2 3 4 5 6 7 8 9 10

Comments: Except for the "lever arm" issue with the ALICE pack that I have already mentioned, both packs fare the same in this category. Again, this falls on the user to pack his gear in a logical and intelligent manner.

Mobility 1 2 3 4 5 6 7 8 9 10

Comments: If there is a good way to be mobile with 80-100 lbs on the back of a Marine, I would appreciate some enlightenment. The primary advantage of the ILBE pack is the existence of the "assault pack" which allows for Marines to use a small book bag sized pack when carrying the enite ILBE pack would be either impossible of tactically inadvisable. The problem with the assault pack is that when used in conjunction with the ILBE is can only be mounted on the back of the ILBE pack, which puts it a significant distance from the wearer, causing weight distribution issues. The only other option is to place an empty assault pack on the back of the ILBE whilst packing all items in the main pack and then transferring items to the assault pack when necessary, which requires a tactical pause, slows down operations, and makes a unit vulnerable.

Compartmentalization 1 2 3 4 5 6 77 8 9 10

Comments: Both packs fare well in this regard. While there are more options for packing methodology in the ILBE pack, it does not have the organic exterior pouches that the ALICE does. Again, as before, this often comes down the organization and intelligence of the user. Signifcant compartmentalization can be created by the use of waterproofing bags (WP Bag, SeaLine bags, ziplock bags, etc).

Additional Comments/Improvements: Ultimately this choice really does come down to personal preference. When I first switched from the ALICE pack to the ILBE I thought that there had been major strides made, but as I continued to use it, I realized that it too had many shortcomings. Furthermore, while in Bridgeport for Mountain Leaders Course, I found that many of the Marines I was attending class with preferred the ALICE pack. This preference seems to be primarily in unconventional units such as Reconnaissance and MARSOC. Finally, it must not be forgotten that these packs fit differently when worn "slick" and when worn in conjunction with body armor.

Pack

ALICE MOLLE ILBE

Weight	1	2	3	4	5	6	7	[8]	9	10

Comments: The ILBE is heavier than the ALICE (or at least seems that way) but not considerably so. The extra weight more than pays off for the benefits it provides.

Durability	1	2	3	4	5	6	[7]	8	9	10

Comments: The pack is durable and repairs are not difficult on the Generation II. The generation 1 clips and zippers broke easily.

Comfort	1	2	3	4	5	6	7	[8]	9	10

Comments: When fully loaded, the ILBE is very comfortable when the waist strap is utilized and adjusted properly. This requires just a few minutes to set it up properly and does not need to be adjusted again. The pack is difficult to adjust on those persons who are of short height.

Weather Resistibility	1	2	3	4	5	[6]	7	8	9	10

Comments: The pack gets soaked easily in the rain and the gear inside will quickly follow suit. It is much larger than the ALICE and needs a poncho or a tarp to cover it in order to keep contents dry. This can be mitigated by waterproofing the inside contents. All zippers and clips are easy to use even with shivering hands or gloved hands due to the large grips.

Gear Accessibility	1	2	3	4	5	6	7	[8]	9	10

Comments: Gear is easily accessible due to side zippers that allow access to any portion of the main pack without moving gear that was above it. There is a top “map pouch” that is considerably larger than the ALICE pack version and makes access to commonly needed gear very easy.

Weight Distribution	1	2	3	4	5	6	7	8	[9]	10

Comments: With such a large main pack section, gear can be organized as to balance weight effectively. Additionally, there are numerous adjustment straps that allow the user to cinch the gear tight to their body.

Mobility	1	2	3	4	5	6	7	[8]	9	10

Comments: The pack is very large and is not suitable for short movements. This is mitigated, however, due to the attached assault pack that can be quickly unclipped and worn for short operations. This assault pack makes the ILBE highly useful for all operations.

Compartmentalization	1	2	3	4	5	6	7	[8]	9	10

Comments: The ILBE has in internal radio pouch, side pouches for mortar tubes, AT-4, or other large objects, and the top map pouch. There is the assault pack which allows for extra gear to be added as well. If the assault pack is overloaded with heavy gear, however, the pack can become off balanced.

Additional Comments/Improvements: The ILBE is a great improvement as compared to previous pack choices. The easy access, proper fit, and detachable assault pack make it a highly practical and useful piece of gear. Making the pack water resistant would be the only addition that would make it an all around great pack.

Pack

ALICE MOLLE **ILBE**

Weight	1	2	3	4	5	6	**7**	8	9	10

Comments:

Durability	1	2	3	4	5	6	7	8	**9**	10

Comments:

Comfort	1	2	3	4	5	6	**7**	8	9	10

Comments:

Weather Resistibility	1	2	3	4	**5**	6	7	8	9	10

Comments:

Gear Accessibility	1	2	3	4	5	6	7	**8**	9	10

Comments:

Weight Distribution	1	2	3	4	5	6	7	**8**	9	10

Comments:

Mobility 1 2 3 4 5 6 **7** 8 9 10

Comments: _____

Compartmentalization 1 2 3 4 5 **6** 7 8 9 10

Comments: _____

Additional Comments/Improvements: _____

Pack SSGT MACHADO USMC 0369

ALICE MOLLE (ILBE)

Weight	1	2	3	4	5	6	7	8	(9)	10

Comments: WEIGHT IS MANAGEABLE FOR ENTRY LEVEL MARINES & SEASONED VETERANS

Durability	1	2	3	4	5	6	7	8	9	(10)

Comments: SOI WHERE STUDENTS ENDURE 9 WEEKS OF BASIC INFANTRY TACTICS. THE ILBE HAS ENDURED COUNTLESS CYCLES

(SOI) SCHOOL OF INFANTRY

Comfort	1	2	3	4	5	6	7	8	(9)	10

Comments: SHOULDER STRAPS ARE HIGH ON YOUR SHOULDERS and BACK SUPPORT WITH HIP BELT ALLOWS DISTRIBUTION OF WEIGHT.

Weather Resistibility	1	2	3	4	5	(6)	7	8	9	10

Comments: ALTHOUGH IT CAN RESIST ~~[illegible]~~ WATER FOR A SHORT TIME TORS PERIODS OF RAIN WILL PENETRATE THE PACK.

Gear Accessibility	1	2	3	4	5	(6)	7	8	9	10

Comments: WHEN PACKING YOUR PACK IF YOU PACK SOMETHING NECCESSARY AT THE BOTTOM YOU HAVE TO REMOVE EVERYTHING FROM THE TOP TO ACCESS IT.

Weight Distribution	1	2	3	4	5	6	7	8	9	(10)

Comments: EXELLENT

Mobility 1 2 3 4 5 6 7 8 9 (10)

Comments: as much as you can expect from a pack it does not bend so mability is still limited

Compartmentalization 1 2 3 4 5 6 7 8 9 (10)

Comments: Storage in this pack is amazing with pouches to store clothing & food is accessible even providing straps to allow extra ammo or wpns to be strapped instead of carried

Additional Comments/Improvements: instead of the pack being large length wise maybe counteracting its hight with width

Pack

ALICE MOLLE ILBE

Weight 1 2 3 4 5 6 7 8 9 10

Comments: A slight heavier than the others, but more comfortable.

Durability 1 2 3 4 5 6 7 8 9 10

Comments: Has options to fit to your size all over.

Comfort 1 2 3 4 5 6 7 8 9 10

Comments: Cushioned. Good fit. Great for military humps.

Weather Resistibility 1 2 3 4 5 6 7 8 9 10

Comments: Fibers good, but all need waterproofing bag

Gear Accessibility 1 2 3 4 5 6 7 8 9 10

Comments: Plenty of room

Weight Distribution 1 2 3 4 5 6 7 8 9 10

Comments: Can hold tons of gear depending on how you pack it

Mobility 1 2 3 4 (5) 6 7 8 9 10

Comments: Good

Compartmentalization 1 2 3 4 5 6 7 8 (9) 10

Comments: Has plenty of Room / No pockets on outside but has a Patrolling pack

Additional Comments/Improvements:

Pack

~~ALICE~~ ~~MOLLE~~ (JLBE)

Weight 1 2 3 4 5 6 7 8 (9) 10

Comments: It's a good weight for what you can fit in it.

Durability 1 2 3 4 5 6 (7) 8 9 10

Comments: I like the material. It lasted pretty well through 1 deployment.

Comfort 1 2 3 4 5 6 7 8 (9) 10

Comments: Maybe the most comfortable pack I have worn especially for how big it is.

Weather Resistibility 1 2 3 4 5 6 7 8 9 10 N/A

Comments: ?

Gear Accessibility 1 (2) 3 4 5 6 7 8 9 10

Comments: Not accessible. If your gear is at the bottom, stuck fishing.

Weight Distribution 1 2 3 4 5 6 (7) 8 9 10

Comments:

Mobility 1 2 (3) 4 5 6 7 8 9 10

Comments: Not mobile. You have to use the day pack if you need to be mobile

Compartmentalization 1 2 (3) 4 5 6 7 8 9 10

Comments: Limited. Unless you use the day pack, you are basically limited to the ~~bag~~ main pack.

Additional Comments/Improvements: Molle is worthless. Alice pack is better than the day pack. But the ILBE offers a pretty good mix. → Plus it carries better and has better compartment.

Sgt Connor

Pack

ALICE MOLLE ILBE

Weight 1 2 3 4 5 6 7 8 (9) 10

Comments: good weight

Durability (1) 2 3 4 5 6 7 8 9 10

Comments: not durable at all, observed many plastic frames snap

Comfort 1 2 3 (4) 5 6 7 8 9 10

Comments: parts of the plastic frame dug into back

Weather Resistibility 1 2 3 4 5 6 7 8 (9) 10

Comments: seemed water resistant, trapped a lot of dirt

Gear Accessibility 1 2 3 4 5 6 7 (8) 9 10

Comments:

Weight Distribution 1 2 3 (4) 5 6 7 8 9 10

Comments: weight seemed oddly distributed

Mobility 1 2 3 4 (5) 6 7 8 9 10

Comments: pack was awkward to put on / sleeping system crossbar was irritating

Compartmentalization (1) 2 3 4 5 6 7 8 9 10

Comments: absolutely horrible, a Marines nightmare, way too many attachments that snap on. Most of them are not used and a lot of gear gets lost

Additional Comments/Improvements: The pack was more of a headache than anything, too many moving parts. It did fit more than the Alice pack though.

Pack

ALICE MOLLE ILBE

Weight 1 2 3 4 5 6 7 (8) 9 10

Comments: Fairly light unloaded

Durability 1 2 3 4 5 6 7 (8) 9 10

Comments: It can withstand a beating. The one I have is fairly old an used frequently, and it still holds up well.

Comfort 1 2 (3) 4 5 6 7 8 9 10

Comments: very crude and uncomfortable

Weather Resistibility 1 2 3 (4) 5 6 7 8 9 10

Comments: If it rains, everything gets wet.

Gear Accessibility 1 2 3 (4) 5 6 7 8 9 10

Comments: If something you need is at the bottom it is extremely hard and frustrating to get it.

Weight Distribution 1 2 3 4 (5) 6 7 8 9 10

Comments: It does put the weight onto your back instead of your ~~sides~~ shoulders.

Mobility 1 2 3 4 (5) 6 7 8 9 10

Comments: ?

Compartmentalization 1 (2) 3 4 5 6 7 8 9 10

Comments: Not very compartmentalized

Additional Comments/Improvements:

Pack

ALICE MOLLE ILBE

Weight 1 2 (3) 4 5 6 7 8 9 10

Comments:

Durability 1 2 3 (4) 5 6 7 8 9 10

Comments: fabric doesn't tear easily but straps and buttons can break easily

Comfort 1 2 (3) 4 5 6 7 8 9 10

Comments: straps uncomfortable

Weather Resistibility 1 (2) 3 4 5 6 7 8 9 10

Comments: soaks up water quickly, need to cover w/ rain fly to keep dry

Gear Accessibility 1 2 3 4 5 6 (7) 8 9 10

Comments: - Easy to access gear

Weight Distribution 1 2 (3) 4 5 6 7 8 9 10

Comments: pack poorly distributes weight,

Mobility 1 2 3 4 (5) 6 7 8 9 10

Comments: doesn't limit freedom of movement

Compartmentalization 1 2 3 4 5 (6) 7 8 9 10

Comments: easy to access ~~Lots~~ most gear

Additional Comments/Improvements: waist strap needs improvement
- doesn't take weight off of back

Pack

ALICE (circled) MOLLE ILBE

Weight 1 2 3 4 5 6 7 (8) 9 10

Comments: Lightly designed pack

Durability 1 2 3 4 5 6 7 8 (9) 10

Comments: solid frame and material for good durability

Comfort 1 2 3 4 5 (6) 7 8 9 10

Comments: Shoulder straps dig into shoulders with substantial weight in pack and the support pack digs into your back

Weather Resistibility 1 2 3 (4) 5 6 7 8 9 10

Comments: Can resist rain for about 15 minutes but most weather resistance is dependent on the user.

Gear Accessibility 1 2 3 4 5 6 (7) 8 9 10

Comments: Has three outer pouches which makes some gear accessible depending on how you pack it

Weight Distribution 1 2 3 4 (5) 6 7 8 9 10

Comments: The weight is not distributed well and a lot of it lies on your shoulders and lower back.

Mobility 1 2 3 4 5 6 7 8 (9) 10

Comments: small pack that fits tight to the body so mobility isn't that restricted

Compartmentalization 1 2 3 4 5 6 (7) 8 9 10

Comments: The three outer pouches are good for compartmentalization but the large pouch does not allow for much compartmentalizing

Additional Comments/Improvements:

Appendix B: Gear Lists

RIFLE RANGE GEAR LIST

Thursday, 31July – Friday, 01 Aug 2008 (pre-qual and qual day)

On Pre-qual Day we bus out and back, on qual day we bus out and hike back

Items Worn/Carried

- M16A2 with cleaning gear in buttstock
- ID Tags
- ID Card
- Room Key
- Green T Shirt
- Socks
- Green MarPat Utilities
- MCMAP Belt
- Boots
- Kevlar
- Note-taking Material (Waterproofed)
- Camelback (Full)
- Soft Cover(in cargo Pocket)

FLC

- 3 Magazine Pouches
- 2 Grenade Pouches
- 2 Canteens w/ covers (Full)
- IFAK
- 1 Compass w/ pouch
- Canteen Cup
- 6 Magazines
- Whistle
- Hearing Protection

Assault Pack

- Data Book (Waterproofed)
- Poly Pro Top and Bottom
- Socks x 2
- Gortex Top
- Gortex Bottom
- Cartridge Belt
- Pistol Holster
- M-9 Magazine pouch x 1
- Pistol Magazines x 2

Armed Forces Officer

- Poncho/Tarp
- Flashlight w/ red lens
- Eye Protection
- E-Tool (Outside Pack)
- MRE
- Plt Cmdr's Tactical Notebook (Laminated)
- Sun Block

- Reflective Belt will go around assault pack during movement to range only.
- Each Squad will have a pole-less litter

GEAR LIST – 6 Mile hike

Items Worn/Carried

- M16A2 with cleaning gear in buttstock and 3 point sling
- ID Tags
- ID Card
- Room Key
- Green T Shirt
- Socks
- Green MarPat Utilities
- MCMAP Belt
- Boots
- Note-taking Material (Waterproofed)
- Camelback (Full)
- Soft Cover

FLC

- 3 Magazine Pouches
- 2 Grenade Pouches
- 2 Canteens w/ covers (Full)
- IFAK
- 1 Compass w/ pouch
- Canteen Cup
- 6 Magazines
- Whistle
- Ear Protection
- Eye Protection

Main Pack

- Kevlar
- WP Bag
- Black Gloves
- Socks x 2
- Green Skivvy Shirt x 2
- Green PT Shorts x 2
- Set of Utilities x 1
- Sleep System
  - Green bag
  - Bivy Sack
  - Compression Sack
- ISO Mat (bottom of pack)

Assault Pack

- Gortex Top
- E-Tool w/Cover
- Socks x 1
- MRE
- Plt Cmdr's Tactical Notebook (Laminated)
- Red Lens Flashlight
- Sun Block
- Poncho/Tarp

- Reflective Belt will go around main pack.
- When Main pack is carried, items from the Assault Pack may be stowed in the main pack or attached to the main pack (front/center).

GEAR LIST – 9 Mile hike

Items Worn/Carried

- M16A2 with cleaning gear in buttstock and 3 point sling
- ID Tags
- ID Card
- Room Key
- Green T Shirt
- Socks
- Green MarPat Utilities
- MCMAP Belt
- Boots
- Note-taking Material (Waterproofed)
- Camelback (Full)
- Soft Cover
- Interceptor Vest (No SAPIs)

FLC

- 3 Magazine Pouches
- 2 Grenade Pouches
- 2 Canteens w/ covers (Full)
- IFAK
- 1 Compass w/ pouch
- Canteen Cup
- 6 Magazines
- Whistle
- Ear Protection
- Eye Protection

Main Pack

- Assault Pack
- Kevlar
- WP Bag
- Black Gloves
- Socks x 2
- Green Skivvy Shirt x 2
- Set of Utilities x 1
- Sleep System
  - Green bag
  - Bivy Sack
  - Compression Sack
- ISO Mat (bottom of pack)
- Gortex Top / Bottom
- E-Tool w/Cover
- Socks x 2
- MRE
- Plt Cmdr's Tactical Notebook (Laminated)
- Red Lens Flashlight
- Sun Block
- Poncho/Tarp
- Poncho Liner

- Reflective Belt will go around main pack.
- When Main pack is carried, items from the Assault Pack may be stowed in the main pack or attached to the main pack (front/center).

GEAR LIST – 12 Mile hike

Items Worn/Carried

M16A2 with cleaning gear in buttstock and 3 point sling
ID Tags
ID Card
Room Key
Green T Shirt
Socks
Green MarPat Utilities
MCMAP Belt
Boots
Note-taking Material (Waterproofed)
Camelback (Full)
Interceptor Vest (No SAPIs)
Kevlar

FLC

3 Magazine Pouches
2 Grenade Pouches
2 Canteens w/ covers (Full)
IFAK
1 Compass w/ pouch
Canteen Cup
6 Magazines
Whistle
Ear Protection
Eye Protection

Main Pack

Assault Pack
WP Bag
Black Gloves
Socks x 3
Green Skivvy Shirt x 2
Set of Utilities x 1
Whole Sleep System
(Black/Green/Bivvy)
Compression Sack
ISO Mat (bottom of pack)
Gortex Top / Bottom
E-Tool w/Cover
MRE

Plt Cmdr's Tactical Notebook
(Laminated)
Blue/Green Lens Flashlight
Sun Block
Poncho/Tarp
Poncho Liner
Soft Cover

- Reflective Belt will go around main pack.
- When Main pack is carried, items from the Assault Pack may be stowed in the main pack or attached to the main pack (front/center).

GEAR LIST – 15 Mile hike

Items Worn/Carried

M16A2 with cleaning gear in buttstock and 3 point sling
ID Tags
ID Card
Room Key
Green T Shirt
Socks
Green MarPat Utilities
MCMAP Belt
Boots
Note-taking Material (Waterproofed)
Camelback (Full)
Interceptor Vest (No SAPIs)
Kevlar

FLC

3 Magazine Pouches
2 Grenade Pouches
2 Canteens w/ covers (Full)
IFAK
1 Compass w/ pouch
Canteen Cup
6 Magazines
Whistle
Ear Protection
Eye Protection

Main Pack

Assault Pack
WP Bag
Black Gloves
Socks x 3
Green Skivvy Shirt x 2
Set of Utilities x 1
Sleep System (Green/Bivvy)
Compression Sack
ISO Mat (bottom of pack)
Gortex Top / Bottom
E-Tool w/Cover
MRE

Plt Cmdr's Tactical Notebook (Laminated)
Blue/Green Lens Flashlight
Sun Block
Poncho/Tarp
Poncho Liner
Soft Cover

- Reflective Belt will go around main pack.
- When Main pack is carried, items from the Assault Pack may be stowed in the main pack or attached to the main pack (front/center).

R-5 Gear List

Items worn

-utilities w/ soft cover
-belt
-boots
-socks
-green t-shirt
-ID card
-ID tags
-three (3) magazine pouches
-six (6) magazines
-IFAK (right side of Marine)
-compass w/ pouch
-two (2) grenade pouches
-two (2) canteens (full) w/ pouch
-Camelback (full)
-one (1) canteen cup
-whistle
-hearing pro
-eye pro
-blue/green lens flashlight
-weapon w/ weapons cleaning gear
-flak jacket (w/SAPIs)
-kevlar helmet

Items carried in ILBE

-Poly pro top and bottom
-two (2) skivvy shirts
-(2) pairs of socks
-poncho/tarp
-one (1) soft cover
-green sleeping bag
-bivvy sack
-black compression bag
-E-tool w/ carrier
-ISO mat (attached to bottom of ILBE)
-(4) MRE's
-reflective belt worn around ILBE
-Gortex top
-black gloves
-note taking material
-platoon commander's notebook
-field sewing kit
-Poleless litter (1 per sqd)
-Terrain model kit (1 per ft)
-Ops Terms and Graphics cards
-hygiene gear

- *The only mandatory placement of items is the iso-mat strapped to the bottom of the ILBE pack and the IFAK placed on the right side of the Marine.*
- *The collar on the flak is NOT an optional piece of equipment.*

R-11 Gear List

Items worn

-utilities w/ soft cover
-belt
-boots
-socks
-green t-shirt
-ID card
-ID tags
-three (3) magazine pouches
-six (6) magazines
-IFAK (right side of Marine)
-compass w/ pouch
-two (2) grenade pouches
-two (2) canteens (full) w/ pouch
-Camelback (full)
-one (1) canteen cup
-whistle
-hearing pro
-eye pro
-blue/green lens flashlight
-weapon w/ weapons cleaning gear
-flak jacket (w/SAPIs)
-kevlar helmet

Items carried in patrol pack

-warming layer
-(1) pair of socks
-E-tool w/ carrier
-(2) MRE's
-reflective belt worn around pack
-Gortex top/bottom
-black gloves
-note taking material
-platoon commander's notebook
-field sewing kit
-Poleless litter (1 per sqd)
-Terrain model kit (1 per ft)
-Ops Terms and Graphics cards

- *The only mandatory placement of items is the iso-mat strapped to the bottom of the ILBE pack and the IFAK placed on the right side of the Marine.*
- *The collar on the flak is NOT an optional piece of equipment.*

FEX I Gear List

Items worn

-utilities w/ soft cover
-belt
-boots
-socks
-green t-shirt
-ID card
-ID tags
-three (3) magazine pouches
-six (6) magazines
-IFAK (right side of Marine)
-compass w/ pouch
-two (2) grenade pouches
-two (2) canteens (full) w/ pouch
-one (1) canteen cup
-whistle
-hearing pro
-eye pro
-red lens flashlight
-soft cover
-weapon w/ BFA

Items carried in ILBE

-**flak jacket (NO SAPIs)/ kevlar helmet inside ILBE pack**
-one (1) set of complete utilities
-two (2) skivvy shirts
-four (2) pairs of socks
-poncho/tarp
-one (1) soft cover
-green sleeping bag
-bivvy sack
-black compression bag
-E-tool w/ carrier
-ISO mat (attached to bottom of ILBE)
-(3) MRE's
-reflective belt worn around ILBE

Items carried in Day Pack

-Camelback (full)
-(3) MRE's (1 is emergency)
-Gortex top
-black gloves
-weapons cleaning gear
-mapping gear
-note taking material
-platoon commander's notebook
-field sewing kit
-Terrain model Kit (1 per ft)
-Poleless litter (1 per sqd)
-Camouflage paint
-Ops Terms and Graphics cards

- *The only mandatory placement of items is the iso-mat strapped to the bottom of the ILBE pack and the IFAK placed on the right side of the Marine.*
- *The collar on the flak is NOT an optional piece of equipment.*

FEX II Gear List

Items worn

-utilities w/ soft cover
-belt
-boots
-socks
-green t-shirt
-ID card
-ID tags
-three (3) magazine pouches
-six (6) magazines
-IFAK (right side of Marine)
-compass w/ pouch
-two (2) grenade pouches
-two (2) canteens (full) w/ pouch
-one (1) canteen cup
-whistle
-hearing pro
-eye pro (NOT OPTIONAL)
-blue/green lens flashlight
-weapon w/ BFA

Items carried in ILBE

-**flak jacket (w/ SAPIs)/ kevlar helmet**
-one (1) set of complete utilities
-two (2) skivvy shirts
-four (2) pairs of socks
-poncho/tarp
-polypro top/bottom
-one (1) soft cover
-green or black sleeping bag
-bivvy sack
-black compression bag
-E-tool w/ carrier
-ISO mat (attached to bottom of ILBE)
-(6) MRE's
-reflective belt worn around ILBE

Items carried in Day Pack

-Camelback (full)
-Gortex top
-black gloves
-weapons cleaning gear
-mapping gear
-note taking material
-platoon commander's notebook
-field sewing kit
-Terrain model Kit (1 per ft)
-Poleless litter (1 per sqd)
-Camouflage paint
-Ops Terms and Graphics cards

- *The only mandatory placement of items is the iso-mat strapped to the bottom of the ILBE pack and the IFAK placed on the right side of the Marine.*
- *The collar on the flak is NOT an optional piece of equipment.*

FEX III Gear List

Items worn

-utilities w/ soft cover
-belt
-boots
-socks
-green t-shirt
-ID card
-ID tags
-three (3) magazine pouches
-six (6) magazines
-IFAK (right side of Marine)
-compass w/ pouch
-two (2) grenade pouches
-two (2) canteens (full) w/ pouch
-one (1) canteen cup
-whistle
-hearing pro
-eye pro (NOT OPTIONAL)
-blue/green lens flashlight
-weapon w/ BFA
-**flak jacket (w/ SAPIs)/ kevlar helmet**

Items carried in ILBE

-one (1) set of complete utilities
-three (3) skivvy shirts
-four (4) pairs of socks
-three (3) pair of underwear
-poncho/tarp
-polypro top/bottom
-one (1) soft cover
-green and black sleeping bag
-bivvy sack
-black compression bag
-E-tool w/ carrier
-ISO mat (attached to bottom of ILBE)
-(10) MRE's
-reflective belt worn around ILBE

Items carried in Day Pack

-Camelback (full)
-Gortex top/bottom
-black gloves
-weapons cleaning gear
-mapping gear
-note taking material
-platoon commander's notebook
-field sewing kit
-Terrain model Kit (1 per ft)
-Poleless litter (1 per sqd)
-Camouflage paint
-Ops Terms and Graphics cards

- *The only mandatory placement of items is the iso-mat strapped to the bottom of the ILBE pack and the IFAK placed on the right side of the Marine.*
- *The collar on the flak is NOT an optional piece of equipment.*

MOUT Gear List

Items worn

-utilities w/ soft cover
-belt
-boots
-socks
-green t-shirt
-ID card
-ID tags
-three (3) magazine pouches
-six (6) magazines
-IFAK (right side of Marine)
-compass w/ pouch
-two (2) grenade pouches
-two (2) canteens (full) w/ pouch
-one (1) canteen cup
-whistle
-hearing pro
-eye pro (NOT OPTIONAL)
-blue/green lens flashlight
-weapon w/ BFA
-**flak jacket (w/ SAPIs)/ kevlar helmet (Ensure neck, throat, and groin protector are attached)**

Items carried in ILBE

-one (1) set of complete utilities
-three (3) skivvy shirt
-four (4) pairs of socks
-polypro top/bottom
-one (1) soft cover
-green and black sleeping bag
-bivvy sack
-black compression bag
-E-tool w/ carrier
-ISO mat (attached to bottom of ILBE)
-(10) MRE's
-reflective belt worn around ILBE

Items carried in Day Pack

-Camelback (full)
-Gortex top/bottom
-black gloves
-weapons cleaning gear
-mapping gear
-note taking material
-platoon commander's notebook
-field sewing kit
-Terrain model Kit (1 per ft)
-Poleless litter (1 per sqd)
-Ops Terms and Graphics cards

- *The only mandatory placement of items is the iso-mat strapped to the bottom of the ILBE pack and the IFAK placed on the right side of the Marine.*
- *The collar on the flak is NOT an optional piece of equipment.*
- *All gear will be taken off of the FLC and placed on the Flak jacket.*

Appendix C: Tactiplane Broucher

MYSTERY RANCH
BOZEMAN MT USA

TactiPlane

Weight:
9 lbs 10 oz

Volume:
Main Bag - 5500 ci
PackLid - 700 ci
Back Pockets - 700 ci
Total - 6900 ci

Mystery Ranch is proud to announce its winning entry in the SOCOM BALCS competition. Combining our latest fitting and stability technology with the 25 year heritage of the Terraplane internal frame packs, Mystery Ranch introduces the TactiPlane.

At 6900 cubic inches, the TactiPlane is right at the maximum size of loads a soldier can effectively haul. Mystery Ranch's proven Lumbar Wrap hipbelt system has been modified with a low profile lumbar pad to work with body armor when neccesary. The Bolstered Ventilation and Stability (BVS) system stabilizes the Tactiplane on your back when wearing armor, and enhances ventilation when you are not.

Proper fit is guaranteed by the Futura sizing system, which adjusts to your height and shape without disturbing the TactiPlane's load. No other internal frame pack adapts to the realities an operator faces when carrying a load like the TactiPlane. 50 pounds in comfort, 70-80 lbs reasonable, and 100 lbs still stable- the TactiPlane helps you cope with whatever the mission requires.

TactiPlane

TactiPlane BVS System

Mystery Ranch
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TactiPlane
Features

MYSTERY RANCH
BOZEMAN MT USA

TactiPlane Central Access

TactiPlane SpeedZip

The TactiPlane packbag lets you distribute your gear for easy access with SpeedZip bottom compartment with a large, secure opening that can handle the largest arctic bivy systems or shrink to let you work with a patrol-sized loads. The packbag has a #10 main access zip between the back pockes that puts everything in the TactiPlane within 8" of your grasp.. Covered by 2 against rain and 2 back up straps against overloading. The main access zip is a major step forward. Long twin back pockets hold gear up to spotting scopes or jackewts, and are accessible when the pack is upright or lying on the ground.

Lower sidepockets you can reach while moving, topped with PAL web midway up the sides let you customize the TactiPlane to your paticular layout. All compression and bottom straps use AutoLock heavy duty (300 lb strength) quick release buckles with Velcro rollup ends to control web length.

Internally, the TactiPlane has a radio pocket against your back and 2 hydration pockets on the sides. More conveniently, you can place a 100 oz hydration reservoir in the front pocket of the PackLid, leaving the larger rear pocket for our smaller neccesities. True to its name the TactiPlane's PackLid has a pair of lightweight shoulder pads attached that let it be used as an assault pack.

Headspace has been carved out of the TactiPlane's upper frame to give you easy situational awareness, even with a helmet- you can look up, and look areound.

The Mystery Ranch Tactiplane- whatever the mission requires.

Available Options:
Quick release shoulder pads
RipZip Side pockets
Zippered Hipbelt pockets

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