Lightening the Load

Briefing to
Honorable Delores M. Etter
Assistant Secretary of the Navy
(Research, Development and Acquisition)

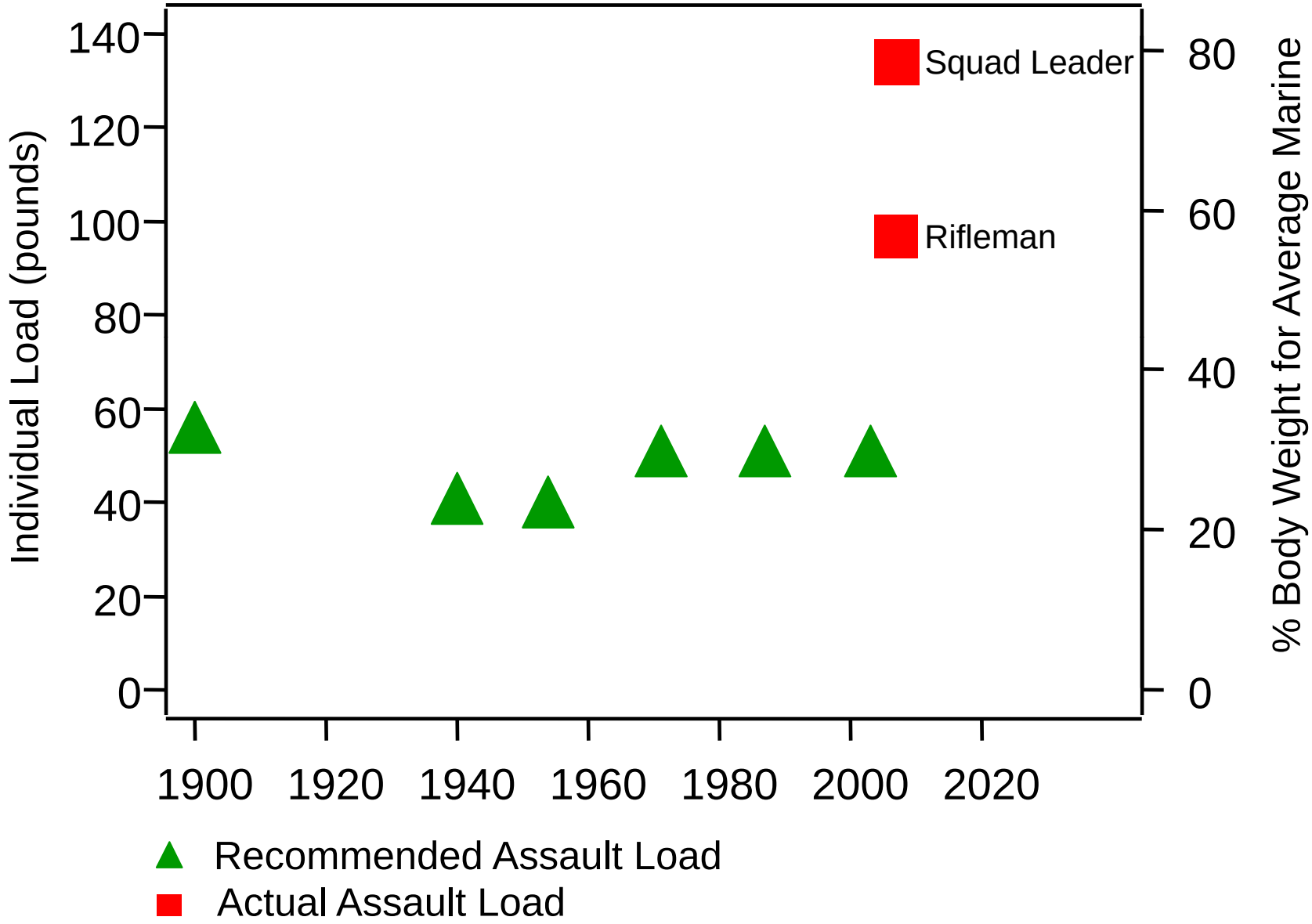
September 2007

"We are careful not to load a mule with more than a third of his own weight."

- Col. S.L.A. Marshall
The Soldiers Load **(1950)**

Lightening the Load

The Problem


Individual Load (pounds)
140
120
100
80
60
40
20
0
% Body Weight for Average Marine
80
60
40
20
0
Squad Leader
Rifleman
1900
1920
1940
1960
1980
2000
2020
Recommended Assault Load
Actual Assault Load

Outline

- **Problem**
- **TOR**
- **Membership**
- **Study Approach**
- **Options**
  - Lighten the load
  - Transfer the load
  - Enhance human performance
  - Establish a systems approach
- **Recommendations**
- **Actions**

Terms of Reference: Objectives

- Assess the elements of the combat load carried by today's Marine
- Identify the primary weight and volume contributors
- Identify and evaluate technology initiatives
- Consider changes in operations, logistics, and training to reduce this burden without having an unacceptable impact on combat effectiveness, safety, or tactics.

Panel Membership

Mr. Jack Bachkosky – Chair
Former Deputy Under Secretary Defense for Advanced Technology

Dr. A. Michael Andrews II – Vice Chair
VP, L-3 Communications; Former Army Deputy Assistant Secretary and Chief Scientist

Dr. Robert Douglas
Member, Army Science Board

BGen James M. Feigley, USMC (Ret.)
Former Commander Marine Corps Systems Command

RADM Lew Felton, USN (Ret.)
Former Chief Engineer, Naval Sea Systems Command

Dr. Frank L. Fernandez
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MajGen Paul Fratarangelo, USMC (Ret.)
NRAC Associate

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Former Deputy Assistant to the Secretary of Defense for Chemical and Biological Defense

VADM Rudy Kohn, Jr, USN (Ret.)
Former Commander, Naval Air Force, US Pacific Fleet

Mr. Norman Polmar
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Mr. Dick Rumpf
Former Principal Deputy Assistant Secretary of the Navy/Acting Assistant Secretary of the Navy (Research, Engineering and Systems)

Dr. John C. Sommerer
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Study Sponsor

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Executive Staff

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Executive Secretary, Fires, Maneuver & Integration Office, Combat Development & Integration

Mr. Greg Kesselring – Consultant
USMC (Ret.), Contractor, Marine Corps Warfighting Lab

Study Approach

- Understanding the problem
- Briefings, reports, and discussions
- Sub-panels
  - Reduce the weight
  - Transfer the load
  - Enhance human performance
  - Systems approach
- Analyzed data
- Examined alternatives
- Developed recommendations and actions

Briefing Topics

- Overview from Army Science Board, PEO Soldier, Distributed Operations, etc.
- LTL Perspective: Organization/Command/Policy
- LTL Perspective: Allies
- Recent Combat Experience Panels
- Marine Corps and Army Lessons Learned
- Experimentation
- Logistics
- PM Current Equipment Status and Plans
- Training
- Technology: ONR, DARPA, Army, MCWL, etc.

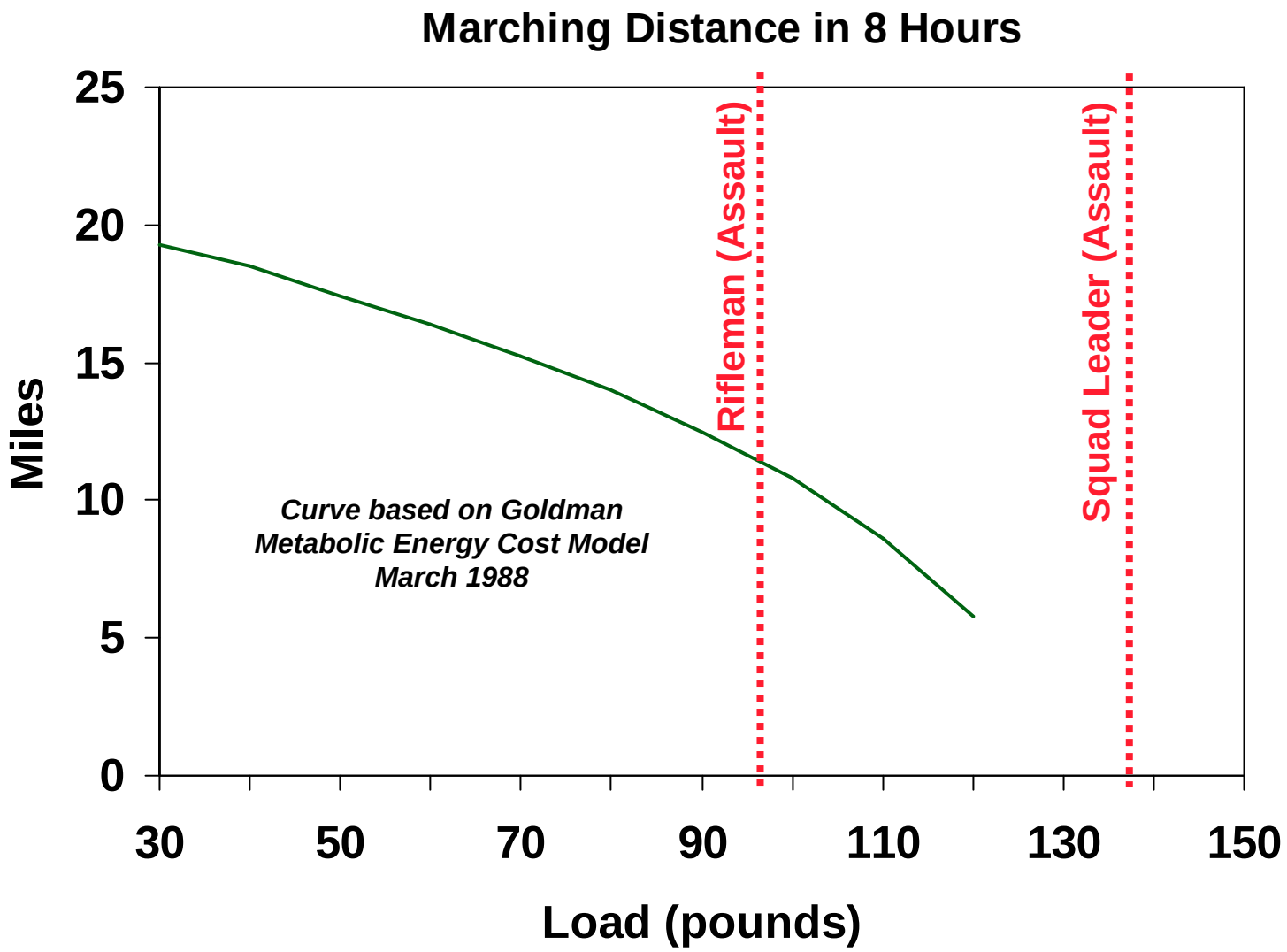
Marine Rifleman Loads

Load Description	Recommended Load*	Current Rifleman's Load**
Assault Load (In the Fight) Conduct combat operations indefinitely with minimal degradation in combat effectiveness	50 lb 30% of body wt based on Avg Marine (169 lb)	97 lb 57% of body wt
Approach March Load (Getting to the Fight) Conduct 20-mile march within 8 hours maintaining 90% combat effectiveness	76 lb 45%	123 lb 73%
Existence Load Limited movement within confines of transportation platforms and limited marching from landing zone into secure area	127 lb 75%	167 lb 99%

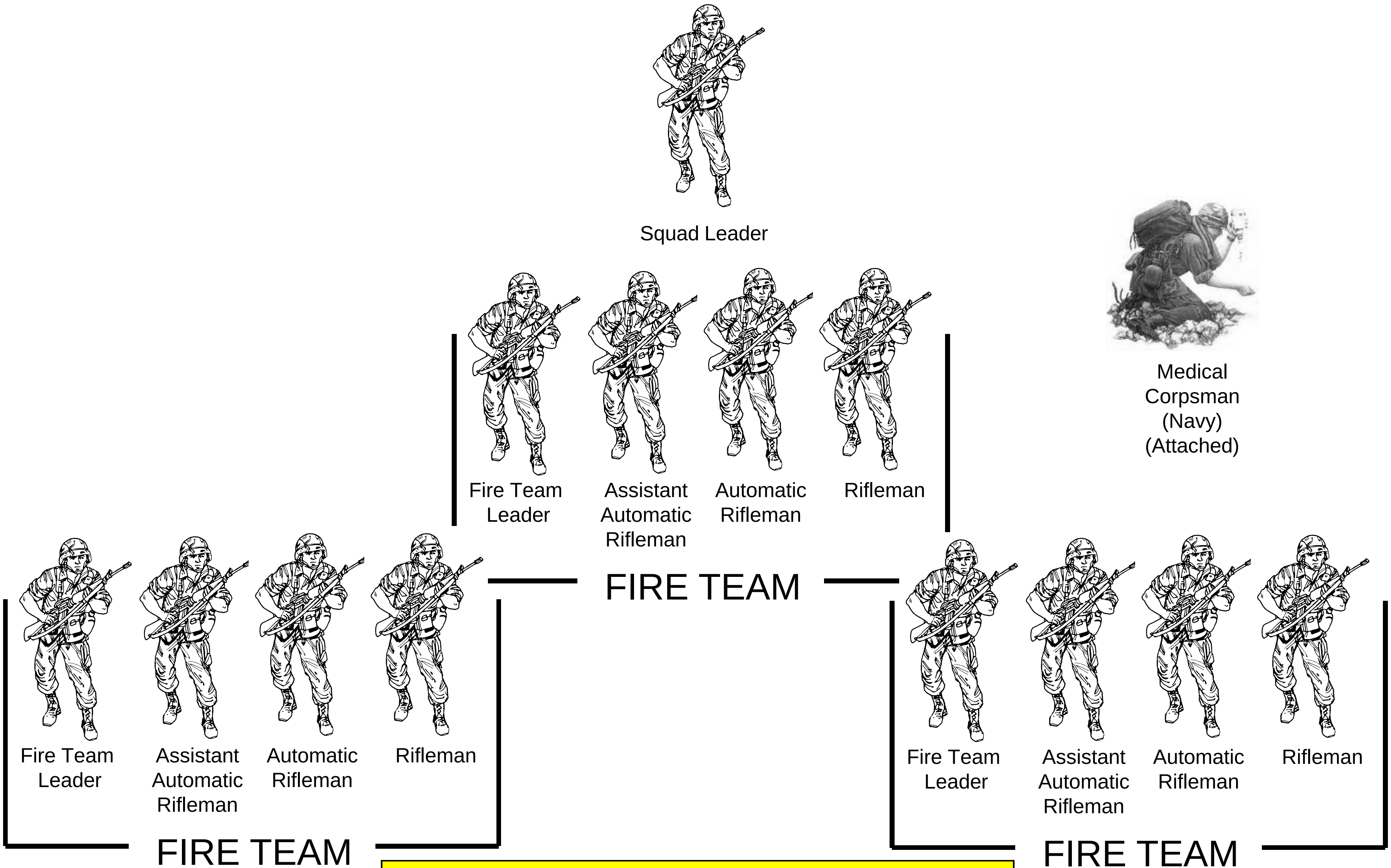
* *MIL-STD-1472F*

** *Information received from MCCDC, Quantico*

Load Impacts Performance

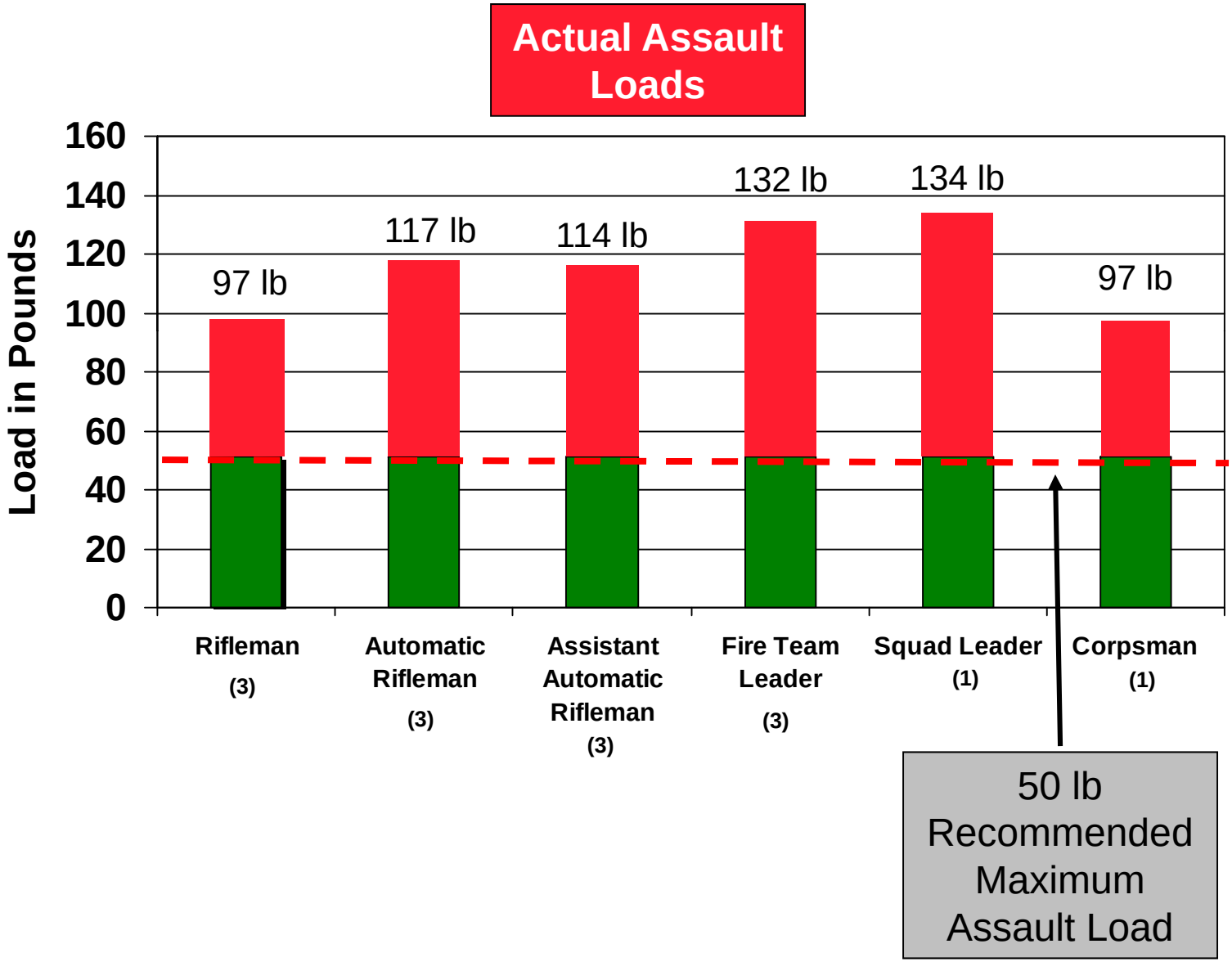


Marine Rifle Squad

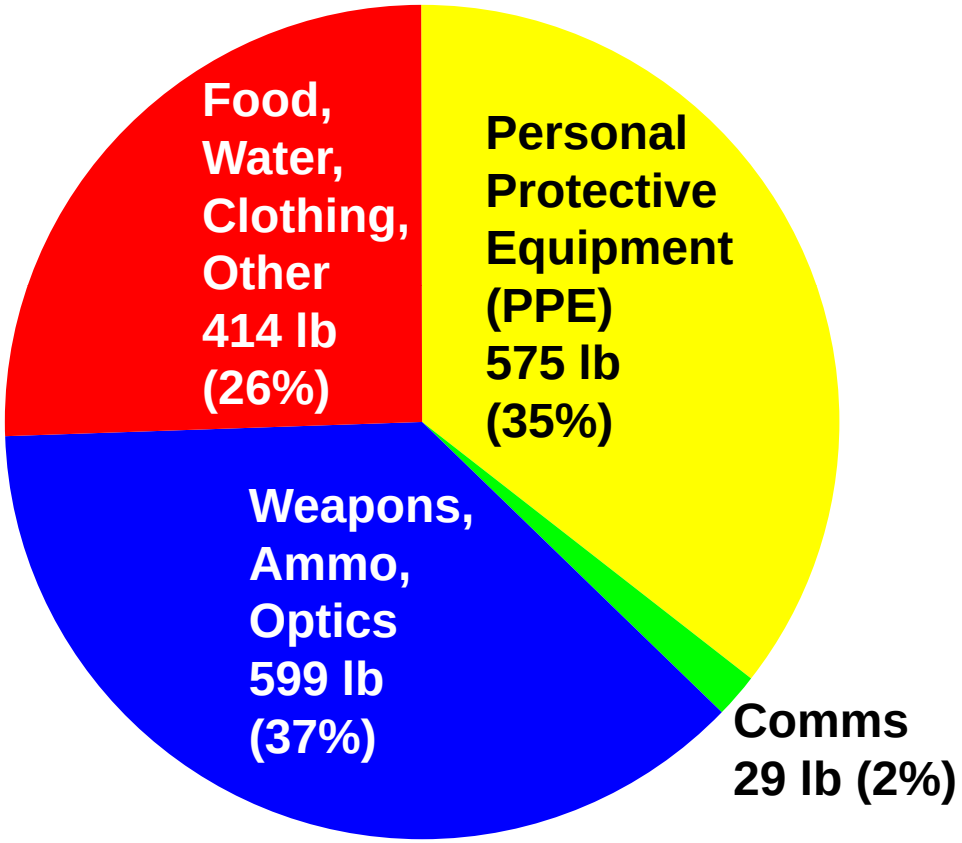


13 Marines plus 1 Corpsman

Individual Assault Load



Squad Assault Load

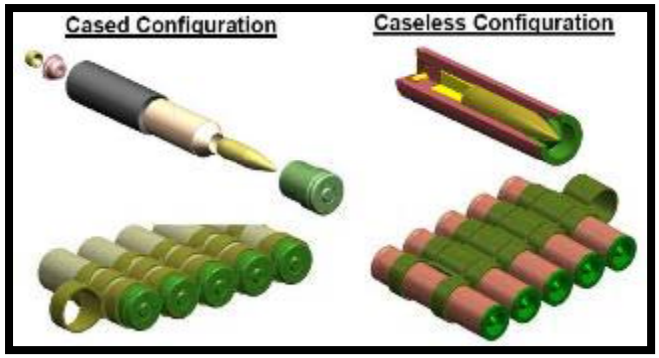


- **Total squad load w/Corpsman ~1,620 lb**
- **Squad load ~900 lb more than recommended**

Top Level Findings

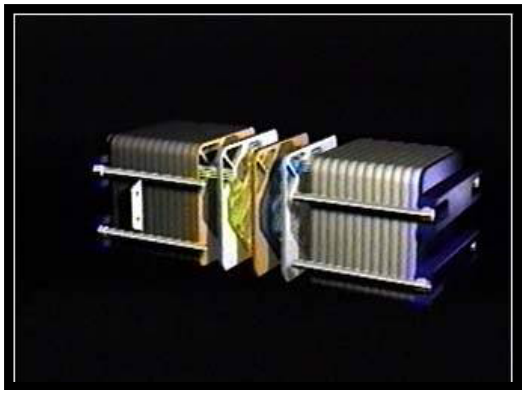
- Individual Marine assault load varies from about 97 to 135 lb vs. 50 lb recommended maximum
- Total Squad Assault load is about 1,620 lb, about 900 lb over recommended maximum Squad load
- Squad and individual equipment are designed and procured independently and are not considered as a system
- Most optimistic outcome of all S&T efforts may result in:
  - ~ 300 lb potential weight savings per squad
  - ~ 300 lb potential weight transfer per squad
  - ~ 300 lb that still needs to be carried or eliminated through tactics
- Over-matching threats exist and will persist
- PM MERS does not have the directive authority, capability or resources necessary to execute systems engineering process

Lightening the Load



Future Ammunition

Future Rifleman



Future Fuel Cell

Reducing the Weight: Investment

- **ONR**
  - $33M in 40 programs (Marine as a system, power, sensors and electronics, warrior performance and protection, and materials)
- **Army**
  - ~$75M for PPE, comms, power, weapons, ammo, food human performance
- **DARPA**
  - Funding levels undetermined
  - Power, load transfer and human performance
- **Navy and Air Force**
  - Funding levels undetermined
  - Load consideration for Corpsmen, Riverine Ops, Seabees, Security

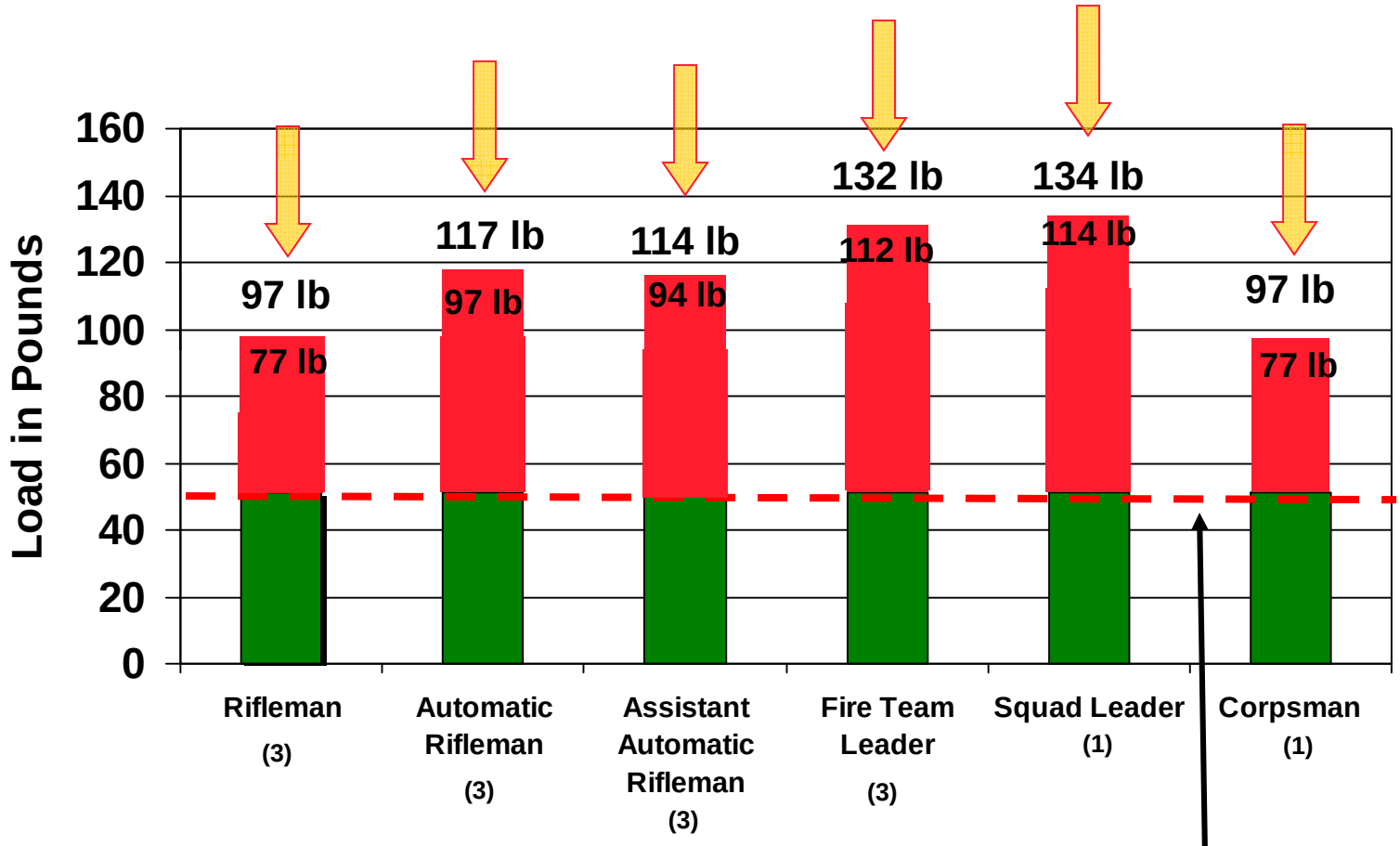
Lightening the Load is about 1% of the DOD S&T Investment

Reducing the Weight: S&T Forecast

Category	~ Individual Weight Savings
PPE – Advanced Materials (nanotechnology)	4 to 6 lb
Weapons and Ammo – Caseless Ammo and Lightweight Weapon	5 lb
Integrated Optics	3 to 7 lb
Overall Marine Systems Integration	2 lb
Advanced Batteries	1+ lb

Possible Savings of ~ 10 to 20 pounds per Marine(~300 per squad but would still be ~ 600 pounds overweight)

S&T Weight Reduction Potential



Squad remains ~ 600 lb overloaded

Transferring The Load

Transferring the Load: Offload

(14) Squad Members

Gas Mask ~6 lb
MREs ~4 lb
Gortex ~4 lb
Face Paint < 1 lb
Patrol Pack ~2 lb

(4) Fire Team / Squad Leaders

Gas Mask Voice Adapter < 1 lb
9 of 18 M203 Grenades ~7 lb

(3) Assistant Automatic Riflemen

1 of 2 Drums 5.56 mm ~7 lb

Assault Squad can transfer ~ 300 lb

Transferring the Load: Offload

Manned/Unmanned Ground Vehicles

- Marine Corps in process of fielding a manned Internally Transportable Vehicle (ITV)
  - Off-board power and a node in the communications network are considered

- Army/DARPA/Allies have invested heavily in unmanned followers and mules

- Provide small unit leaders organic access

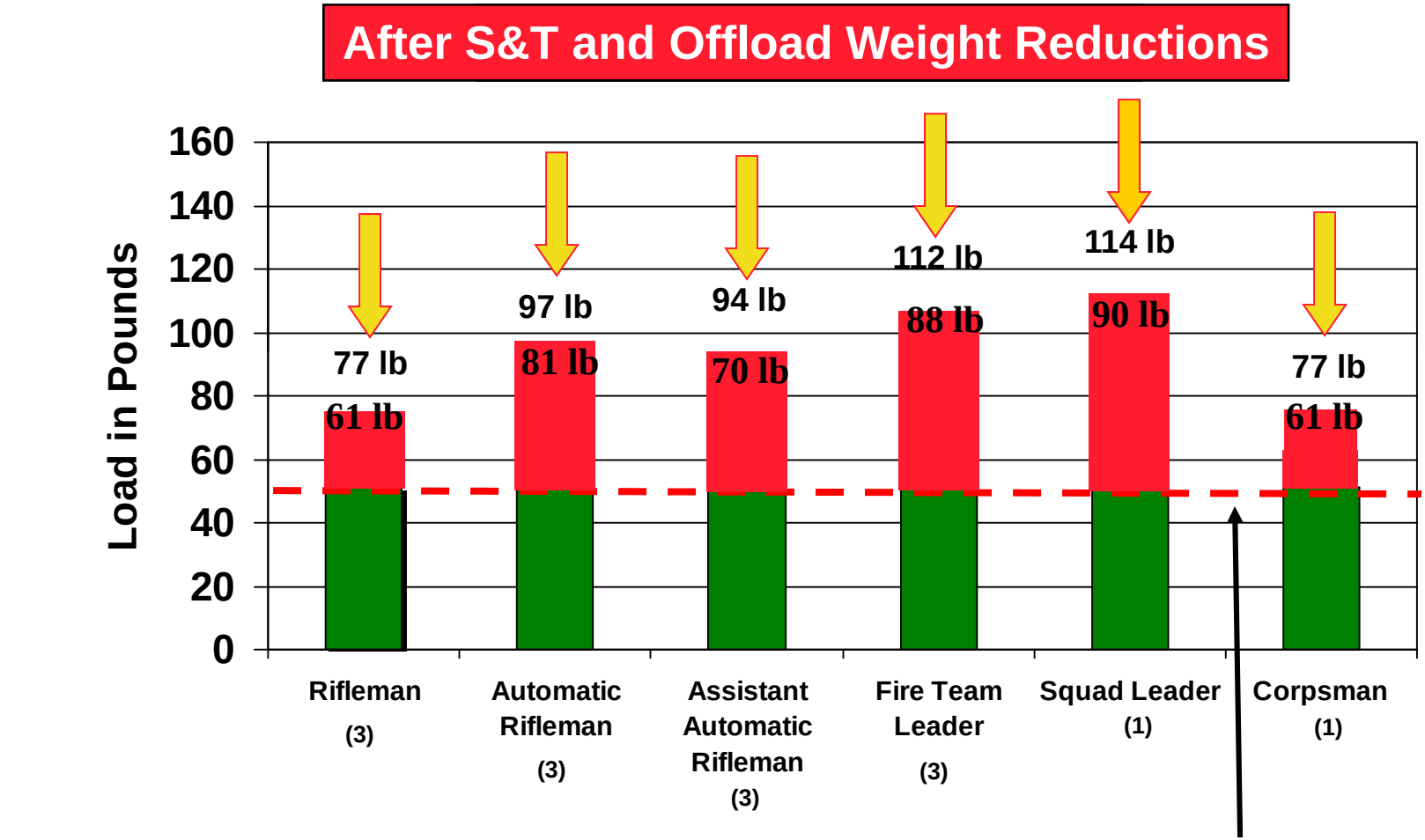
Transferring the Load: Offload

Manned/Unmanned Aviation Vehicles

- Marine aviation has capability to provide direct support to small units – limited by number of platforms
  - Support designated squads as primary customers

- Navy/Army/DARPA are investing in unmanned air vehicles for cargo loads of 30 to 300 lb

Offload Weight Potential Savings



Squad remains ~ 300 lb overloaded

Enhance Human Performance

Enhance Human Performance

- **Combat effectiveness**
  - Impacted by numerous factors, including fatigue, psychological stress, nutrition, environmental conditions, etc.

- **Physiological Models and Metrics**
  - Adequate models do not exist that incorporate combat effectiveness parameters and predict human performance

Enhance Human Performance: Options

- Nutrition
  - First Strike Rations provide more calories and carbohydrates to boost energy
  - Caffeine supplements now included in MREs
  - Other supplements (tyrosine, quercetin, etc.) are being studied
- Physical training
  - Functionally designed to address operational environment
  - Tailored to individual
- Ergonomics
  - Research programs to balance the load and assess fatigue contribute to understanding the decrements in performance

Nutrition, ergonomics and physical training…only marginal difference

Enhance Human Performance: Tactics & Training

- Advanced tactical concepts (e.g. Combat Hunter) may permit reducing the combat load

- Early indications point to a possible reduction in squad operational risk
  - Presents an opportunity to reduce weight that compensates for risk

- Advanced immersive training simulators will further advance tactical changes
  - Presents high fidelity conditions that enable higher standards for performance
  - Provides further opportunities to decrease risk induced weight burdens

A Fundamental Change To Lighten The Load Is Needed!

(More game changing concepts like “Combat Hunter”)

To further reduce squad weight in the near term, and accommodate changing needs without increasing weight.

An Example: Game Changing Concept

- A Squad that can rapidly:
  - Find the enemy through advanced ISR in complex terrain
  - Fix the enemy location with precision
  - Finish the enemy (organically or with other resources)

…can then decrease their load

…and accommodate new challenges without increasing individual Marine weight

Weight ↓ = ↑ Performance

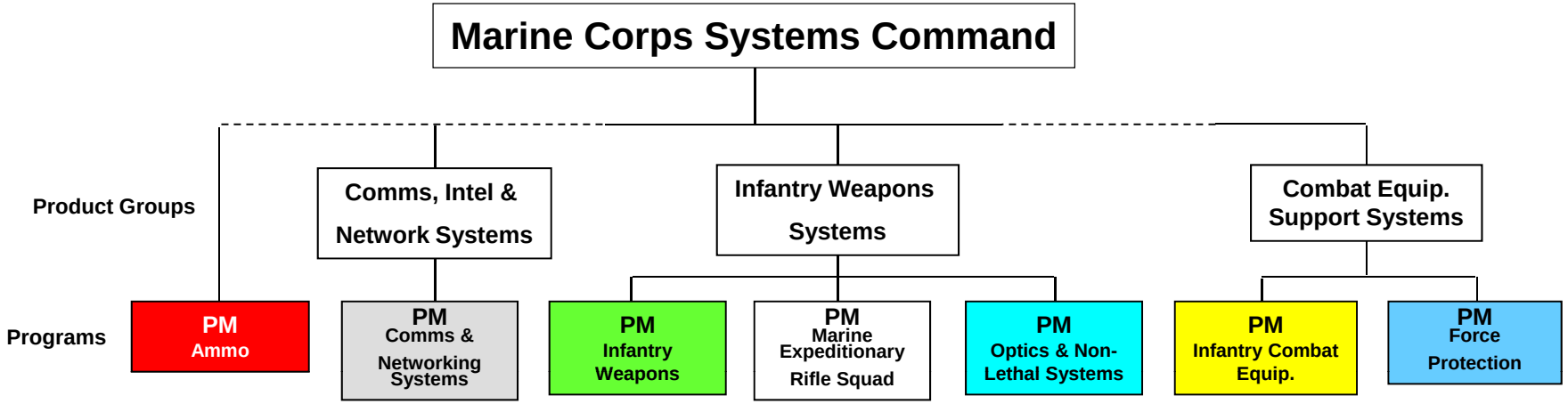
Game Changing Concept (cont'd)

- Current sequential development process is ineffective…Change is needed!
- Requires a new approach to systems development
  - Parallel / integrated development of tactics, technology and training; experimentation; iteration
  - System level models to allow tradeoffs between weight and other squad combat performance variables…and to design experiments

"Game changing approaches require game changing processes."

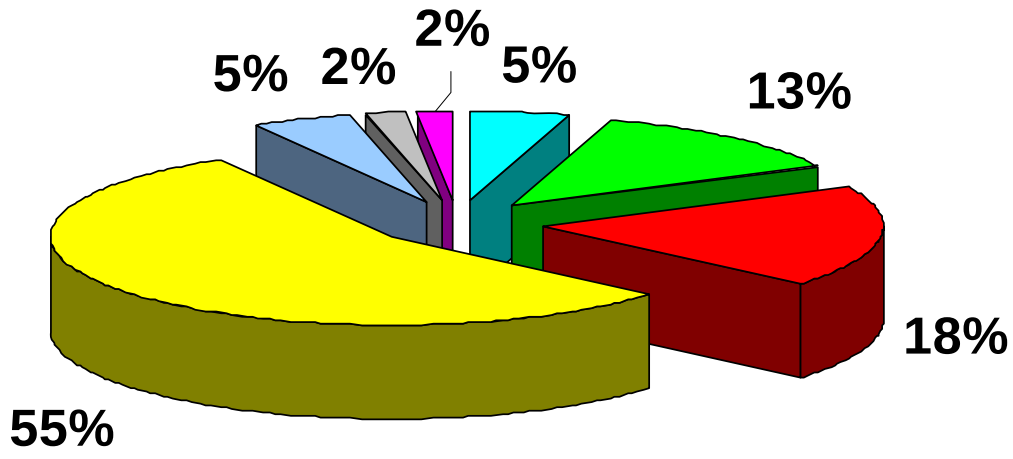
Systems Approach

Current Acquisition Approach



- Seven program managers contribute to squad equipment/ weight
- PM MERS was created to provide systems engineering for the squad
- Systems engineering “drives the balanced development of systems products”

MCSC Distribution of Weight



Marine Rifleman

Lightweight Kevlar Helmet

Ballistic Eye Protection

Hydration Device with Water Purification System

Fire Retardant Gloves

First Aid Kit

Fragmentation Grenades
Smoke Grenade
M16 Magazines

Bayonet Scabbard

Knee Pads

Combat Boots

AN/PVS-14 Night Vision

Personal Radio
(Headset and Radio)

Ballistic Hearing Protection

Tactical Vest
w/Small Arms Protection Inserts (PPE)

Rifle Combat Optic

Elbow Pads

AN/PEQ-2A Laser Pointer

M16A4 Rifle
w/ Sling

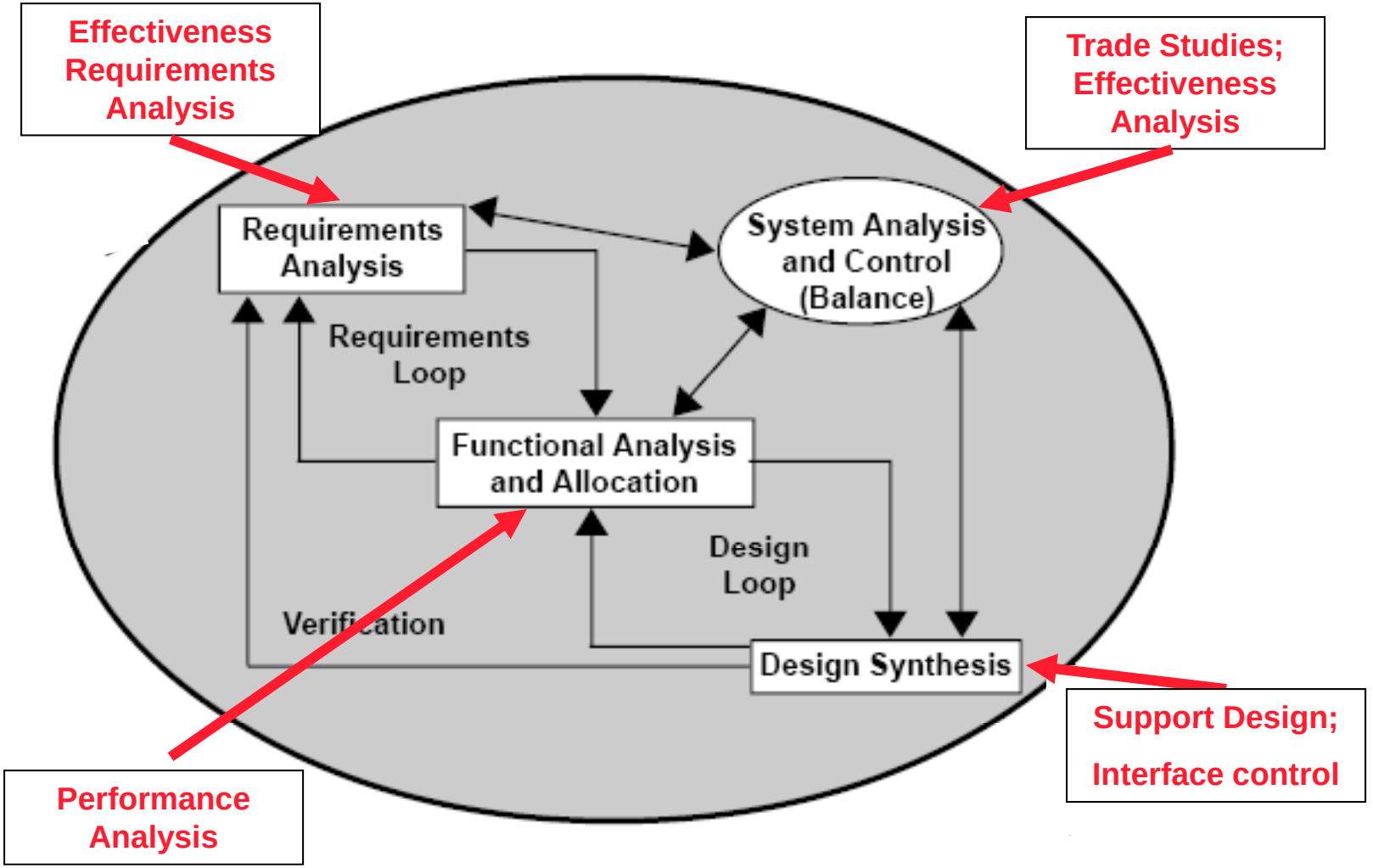
M9 Bayonet

Digital Camouflage Uniform

Not Shown:
- Grip Pod on M16A4
- Cooling Vest
- Fire Resistant Balaclava
- Load Bearing Equipment
- Gas Mask

November 2006

Systems Engineering Process



- **Modeling and Simulation Tools to support Systems Engineering Process are inadequate**
- **Very limited experimental data available**

Systems Approach: Findings

- PM MERS does not have the directive authority necessary to execute an effective systems engineering process
- Data and system level models are needed for development of requirements and implementation of systems engineering process
- Data and system level models on relationship of squad equipment weights to mission effectiveness – do not exist
- PM MERS is unable to conduct trade-off analysis to reduce squad load and/ or increase squad effectiveness. Areas include:
  - Weapons (range, accuracy)
  - Survivability
  - Mobility
  - Sensors / situation awareness
  - Logistic responsiveness
  - Immediate fires

Present and Future Trade-Offs

Dedicated ISR

Dedicated Assault
Support / Resupply

Helmet Integration including
Fused Optics

Lighter Weapon using
Caseless Ammunition

Lighter Body Armor

Single Power Source
Weapons
Marine

Integrated, Multi-Band
Communications

Physical and Operational Training

Performance Enhancement
Supplements Available

MULE with Battery
Recharging and Comm Hub
Capability

Systems Approach Conclusions

- **PM MERS** was established as a program office to ***institute systems integration*** but has not fully matured due to a ***lack of authority, resources, and capabilities***
- ***Reductions in weight*** will not be realized without a ***systems engineering approach***
- ***A disciplined systems engineering approach is mandatory*** as we move toward the future Marine and introduce new capabilities into the squad as a system
- ***Trades of weight vs. new capabilities*** must be conducted to ensure projected weight reductions ***enabled through S&T and weight transfer*** are not eroded

Recommendations & Actions

Recommendations

- **Science & Technology**
  - Protect current investment – IT IS THE FOUNDATION
  - Increase Marine Corps engagement with ONR and interaction with DARPA
  - Increase efforts to reduce load and improve Marine Rifle Squad lethality, survivability, mobility and training

- **Models**
  - Assess impact of load on individual combat effectiveness
  - Perform Marine / Squad system level trade offs
  - Provide Small Unit Leaders load planning tools to assess impact of load, environment, physiological status on combat effectiveness

- **Experiments**
  - Collect data required to populate, calibrate the models
  - Conduct Limited Objectives Experiments (LOE) focused directly on tactical concepts and support technologies to reduce squad weight
  - Concurrently analyze training and future technologies required to implement promising concepts

- **Management**
  - Recognize and develop Marine Rifle Squad as a system

Actions

- **ASN (RDA)**
  - Increase ONR investment in Lightening the Load
  - Advocate appropriately funded, multi-service S&T program for Lightening the Load with DDRE
- **CMC**
  - Engage with the Director DARPA to nominate Program Managers and Marine Liaison Officer
  - Establish partnership with DARPA on advanced ISR, lethality, tactics to reduce weight, improve survivability and combat effectiveness
- **DC CD&I**
  - Establish maximum load weights for the Marine and the Rifle Squad
  - Ensure Integration Divisions and MCWL are effectively coordinating with ONR
  - Annually review all Marine Corps programs at ONR
- **COMMARCORSYSCOM**
  - Assign total “Squad as a System” management authority to PM MERS
  - Provide resources to create effective “Squad as a System” systems engineering capability
- **CNR / VCNR**
  - Develop, validate and deliver three models to MARCORSYSCOM:
    - Squad combat effectiveness as a function of load, terrain, environment and other pertinent parameters
    - Impact of load on individual performance (endurance, mobility, combat effectiveness, etc.)
    - Models for system trade of studies (ISR capability, lethality, weight, mobility, survivability, etc.)
  - Capitalize on all unmanned vehicle developments to satisfy organic needs of the Marine Rifle Squad

"We were ordered to wear everything everywhere in the mountains all the time…Even if you were in great shape, you couldn't keep up with the enemy."

- Commanding Officer,
1st Bn, 3rd Marines
14 Nov 2006

“Ounces equal pounds and pounds equal pain.”

- Marine Corps NCO Lessons Learned Conference August 2005