



PERSONNEL AND
READINESS

UNDER SECRETARY OF DEFENSE
4000 DEFENSE PENTAGON
WASHINGTON, D.C. 20301-4000

MAR 30 2022

The Honorable Adam Smith
Chairman
Committee on Armed Services
U.S. House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

The Department's response to House Report 116-442, pages 153-154, accompanying H.R. 6395, the William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, on Force Plate Technology Utilizing Machine Learning for Improving Combat Readiness, is enclosed.

The Department worked closely with the Military Departments to develop a response to the requested elements that describes efforts to incorporate Force Plate Technology and other technologies into the portfolio of inputs used to ensure Service member readiness and protect the force – prevent and reduce injuries at the individual level. While additional consideration is needed, Force Plates and similar technologies can potentially serve as one tool within a portfolio that enables the Department to make informed programming and management decisions to protect and sustain the force and ensure combat readiness at the individual level through human performance professionals.

Thank you for your continued strong support for the health and well-being of our Service members. I am sending a similar letter to the Senate Armed Services Committee.

Sincerely,

A handwritten signature in black ink, appearing to read "Gilbert R. Cisneros, Jr.", written in a cursive style.

Gilbert R. Cisneros, Jr.

Enclosure:
As stated

cc:
The Honorable Mike D. Rogers
Ranking Member



PERSONNEL AND
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MAR 30 2022

The Honorable Jack Reed
Chairman
Committee on Armed Services
United States Senate
Washington, DC 20510

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Enclosure:
As stated

cc:
The Honorable James M. Inhofe
Ranking Member

REPORT TO THE CONGRESSIONAL ARMED SERVICES COMMITTEES



Report on Force Plate Technology Utilizing Machine Learning for Improving Combat Readiness

House Report 116-442, Pages 153-154, Accompanying H.R. 6395, the William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021

March 2022

The estimated cost of this report or study for the Department of Defense (DoD) is approximately \$3560 for the 2021 Fiscal Year. This includes \$0 in expenses and \$3560 in DoD labor.

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A. CONGRESSIONAL REPORT REQUEST

This report is in response to House Report 116-442, pages 153-154, accompanying H.R. 6395, the William M. (Mac) Thornberry National Defense Authorization Act (NDAA) for Fiscal Year 2021, that requests the Secretary of Defense, in collaboration with the Secretaries of the Military Departments, submit a report to the Committees on Armed Services of the Senate and the House of Representatives by September 1, 2021, assessing how force plate technology (FPT) and machine learning could be leveraged to improve the medical readiness of individual Service members.

This report shall include the following elements:

1. A list of units currently using this technology and the impact it has had on unit readiness;
2. An analysis of how this technology could be leveraged to create a more deployable, resilient and sustainable combat force;
3. A determination of Service member attrition and injury reduction from using Force Plate Machine Learning Technology;
4. A determination of the appropriate component within each Military Service that would be the responsible entity for implementing customized training regimens for new recruits, active duty and reserve forces;
5. A determination of the feasibility of a customized fitness program for each warfighter to minimize musculoskeletal injuries during both home station and deployed status;
6. The projected cost of employing this technology versus the cost of lost man days due to injuries or attrition; and
7. The projected potential savings from injury avoidance.

B. PROCESS

Military Service subject matter experts (SMEs) were interviewed and provided input on the seven congressionally-requested elements affiliated with FPTs. Developing responses to the elements requires context on applicability, availability and use of similar / comparable systems, integration of data from multiple sources, evolving empirical information, and overall state-of-the-science.

C. FINDINGS: RESPONSES TO CONGRESSIONAL ELEMENTS

1. A list of units currently using this technology and the impact it has had on unit readiness.

The Military Services generally make use of FPT and similar technologies in training and high performance units where SMEs are available (Table 1). Impact on unit readiness is premature to ascertain as research on FPT and similar technologies is being collected and evaluated.

Table 1. Responses to Element 1 (list of units currently using this technology and the impact it has had on unit readiness)

Air Force	Units from the Air Force Special Operations Command 24th Special Operations Wing, Air Education and Training Command Special Warfare Training Wing, Air Combat Command 4th Fighter Wing, limited number of Rescue Squadrons, and Air Force Research Laboratory Signature Tracking for Optimized Nutrition and Training Lab.
Army	<p>This technology is being used: (1) during some initial entry training; and (2) in units with human performance staffs, including strength coaches. Advanced Medical Technology for human performance and Biomechanics research and Army Combat Capabilities Development Command (DEVCOM) Soldier Center Biomechanics team who have submitted internal funding proposal to purchase VALD Performance ForceDecks and Sparta Science system to correlate force plate measures, algorithms, and Army Combat Fitness Test performance and in collaboration with U.S. Army Physical Fitness School. The XVIII Airborne Corps is in the process of a pilot implementation.</p> <p>Units without professionals to interpret the data should not be using this technology at this time. Special Operations Forces elements are the biggest current users, because they have robust human performance (HP) staffs to collect and interpret this data, and program training based on the results. Army assessments indicate that it is premature or inappropriate in some cases to implement technology at some units.</p>
Navy	There are seven (7) Echelon III commands within Navy Special Warfare (NSW) Center that have FPT. All operational commands with deployable forces have the technology. It is used as one of six (6) assessment tools to recommend operational readiness of the Force.
Marine Corps	Officer Candidate School, The Basic School (TBS), Force Fitness Readiness Center, School of Infantry (SOI)-East, SOI-West, Marine Corps Recruit Depot (MCRD) San Diego, MCRD Parris Island. The 1st Battalion 6th Marines is currently using one set

	<p>of Sparta Science jump plates and one set of VALD Performance ForceDeck jump plates.</p> <p>FPT is used during entry level training in order to aid physical performance, identify musculoskeletal (MSK) injury risk, and guide developmental and corrective exercise programs.</p> <p>Force plates are also being used as part of ongoing human performance studies. An Office of Naval Research/West Virginia University (WVU) study is being conducted at Marine Corps Infantry Officer Course (IOC) to develop and provide a capability for assessing Marines in order to identify why they either successfully complete IOC or attrition occurs during the course. A study led by the U.S Army Research Institute of Environmental Medicine is being conducted at TBS to examine body composition and physical performance of students at the beginning and end of the TBS 6-month training cycle. WVU is evaluating:</p> <ul style="list-style-type: none"> • Force Plates: ForceDecks (VALD), Hawkin Dynamics, Bertec, Sparta Science. • Mobility/Movement Assessment tools: HumanTrak (VALD), OptiTrack, DARI Motion. • Group Based External Training Load Monitoring: Catapult GPS, StatSports GPS, Kinexon RFID, Zebra RFID. Group Based Internal Training Load Monitoring: Polar Team, FirstBeat Team, Zephyr Bioharness, VX Sport. • Personal Training Load Monitoring: Polar Watches, Garmin Watches, iWatch, FitBit, Samsung. • Recovery Assessment Tools: OURA Ring, HRV4Training, EliteHRV, OmegaWave, Kubios HRV. Subjective Survey Tools (multiple). • Weight Room Monitoring (Programming): BridgeAthletic, TrainHeroic, Teambuildr. • Weight Room Monitoring (Velocity): GymAware, Tendo, Perch, EliteForm. <p>No impact on unit readiness may be determined at this time.</p>
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2. An analysis of how this technology could be leveraged to create a more deployable, resilient and sustainable combat force.

FPT and similar technologies can potentially serve as one tool among many enabling HP professionals and leadership to make informed combat readiness decisions (Table 2). While Military Service research and implementation efforts continue, a series of studies and investments are required to identify whether and how best to utilize this technology.

Table 2. Responses to Element 2 (analysis of how this technology could be leveraged to create a more deployable, resilient and sustainable combat force)

Air Force	This subject needs to be evaluated further, including: a query of existing technologies and their capabilities; a series of targeted assessments using observational studies; simple tech evaluations; controlled clinical trials; and appropriate technology investment once gaps are identified
Army	<p>FPT can potentially serve as one tool among many enabling human performance professionals to make informed programming decisions. We should not tie to any one company, software, or style. Provides an assessment tool for symmetry, power production, movement patterns, risk factors, etc. It is most useful in a research setting and some limited rehabilitation settings. We do not see it in general use at this time. Additionally, if further developed, and provided with expert trainers and operators, it might be able to assist in screening out high injury risk candidates or identify recruits that should be referred for remedial physical training prior to initial entry training. There are, however, other low cost options that can accomplish this task. It could also be used in return-to-duty evaluations, for example, if a soldier needed surgery, physical therapy could use their pre-injury data as a goal for rehabilitation outcomes.</p> <p>FPT are not novel to the assessment of HP and has long been used in Soldier performance labs like DEVCOM Soldier Center's to quantify Soldier strength, power, and stability. Force plate s may also be used by appropriately trained professionals as one tool among a suite of assessments to make recommendations about physical training improvements and injury recovery techniques. A deployable FPT that provides usable, reliable, and validated data to these qualified professionals could be of aid to creating a more deployable, resilient, and sustainable combat force.</p>
Navy	By using FPTs we can rapidly and safely provide the HP team with information on mechanical efficiency, force production, power, landing strategy, asymmetries, and eccentric loading tendencies of the operator. This individual profile can provide a baseline of individualized programming to address any factors that impede performance. This is one assessment tool that have been widely accepted and used within NSW. We have buy in from the operators and positive feedback from the active duty community.

	<p>However, technology alone cannot be assessed for this purpose without HP SMEs. The first rule of performance science monitoring is not to let the data alone drive decisions. With proper measurements and methodologies, these data can help inform HP SMEs for more targeted training and recovery. These tools can be used in concert with other inputs to provide performance practitioners and health care providers with quantitative data to support their decision making processes. This can result in more appropriate, safe, and effective training and recovery processes for increasing psychophysiological and neuromuscular preparedness for duty and resiliency to injury risk factors.</p> <p>Additionally, to deploy a tool like force plates across the combat force would require the proper procedures and methodologies to be followed.</p>
Marine Corps	<p>Not available until system becomes fully operational on Marine Corps network. The U.S. Marine Corps, led by Human Performance Branch, is working with SMEs to validate and approve the Force Plate Machine Learning™ (FPML™) software for Marine Corps network access and data storage.</p> <p>Using Jump Plate technology could help identify potential injuries prior to total loss. The data the jump plates provide can be used to identify where an individual is weaker than others and can provide training on how to improve those weaknesses. Another option this data could provide is an insight to what individuals could sustain in which training based on their musculoskeletal configuration. This could assist in better military occupational assignments.</p>

3. A determination of Service member attrition and injury reduction from using Force Plate Machine Learning Technology.

While FPT has been used in a number of units and is actively being researched, FPML™ and similar technologies have not been validated against military subpopulations to allow for their employment (Table 3). Therefore, it is not possible at this time to determine member attrition and injury reduction from FPML™ and similar technologies.

Table 3. Responses to Element 3 (determination of Service member attrition and injury reduction from using Force Plate Machine Learning Technology)

Air Force	A validation of FPML™ would be one study in this portfolio of technological options. (Similar technologies exist.)
Army	FPML™ does not, on its own, do anything. It produces data that could potentially enable programs that achieve these goals. There

	<p>are many companies, software, and technologies that are of assistance in determining capabilities, injury, and rehabilitation needs. Trained Physical Therapy providers and Sports Medicine Doctors can perform much of this screening and assessment without the need for these additional tools. It may have some value but at a cost. Impact on attrition could come from using any of several FPT in a screening capacity by developing performance thresholds to either require additional approvals/medical evaluations to join the military, potentially require a pre-initial entry training physical training regimen, or impact assignment of occupational specialties. In most cases it would serve to “screen out” rather than “screen in” recruits, thus lowering the pool of recruits and increasing the recruiting challenge.</p> <p>Measures obtained from force plates identifying asymmetries have been published in the literature and are shown to correlate with increases in injury risk and changes obtained during rehabilitation from injury. If enough data can be obtained about these Force Plate-based asymmetries or other validated measures, taken from a military population, using machine learning or other data science techniques could potentially determine Service member injury risk and attrition. These two distinctly separate approaches could be used in conjunction with actual attrition data and collectively be a powerful tool for the military. The injury prediction applications of deployable FPTs and their machine learning algorithms have not been scientifically validated. Until such validations occur, it is incorrect to project any expectation of Service member attrition or injury reduction. Analyses of relevant FPT, machine learning algorithms, and their injury prediction mechanisms are underway among two of the Armed Services. These publications should be looked to for guidance when available.</p>
Navy	<p>A force plate evaluation only is not a one stop shop for an assessment. Nor do we put all of our resources in one evaluation. The relationship between the HP staff member and the operator creates a trust in the program and the command that we are trying to optimize and sustain performance throughout their career. This is not possible at this time.</p> <p>First, force plates are not new or novel, but they are a tool used for measurement. Machine Learning is not new or novel, but it is an analysis tool used widely. Using these two tools together is not new.</p>

	If a determination on use of FPML™ was required, then a double-blinded placebo controlled training study must be undertaken with training programs simultaneously utilizing and not utilizing FPT specifically to guide training programming. Simply conduction of measurement with a force plate and even employing machine learning does not create a change. The presumption is that the data from this would be used to create a custom training plan that is distinctively different from the current training plan and specific to that data. In order to scientifically assess impact on attrition and/or injury, a very large cohort of research subjects would need to be recruited and consented through an Institutional Review Board approved clinical trials study. Half of those subjects would need to follow a traditional strength and conditioning plan, and the other half would need to get a customized plan based on these data. Both the researchers and subjects would need to be blinded to which group they are assigned to. Then they would need to strictly adhere to these plans over many months and monitored for all injuries. They would also need to be standardized to make sure both groups are going through the same military training at the same time. This is the only scientifically valid way to assess this.
Marine Corps	This cannot be determined at this time.

4. A determination of the appropriate component within each Military Service that would be the responsible entity for implementing customized training regimens for new recruits, active duty and reserve forces.

The Army indicated their overall lead is the Army’s Center for Initial Military Training or Marine Corps’ Training and Education Command (Table 4). Other Military Services are awaiting how FPML™ and similar technologies would integrate with other input parameters used to develop customized training for various forces from entry level (e.g., new recruits) to active duty (to include special forces) and reserve forces.

Table 4. Responses to Element 4 (determination of the appropriate component within each Military Service that would be the responsible entity for implementing customized training regimens for new recruits, active duty, and Reserve forces)

Air Force	This depends on the capability of each technology under review. For example, some technologies (SpartaTrac) provide automated recommendations for training adjustments, so implementation is relatively straightforward and nearly automated. Other technologies would require the interpretation of a SME to make training adjustments. Regardless, none of these technologies currently have a delivery platform native to the capability itself so a new process would need to be developed or modified for this purpose.
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Army	U.S. Army Center for Initial Military Training, Army lead for Holistic Health and Fitness; U.S. Army Training and Doctrine Command.
Navy	A force plate assessment early on in your active duty career could provide baseline metrics to improve certain motor patterns or used as a bench mark to return an individual back to operational readiness after a MSK injury. Provides the HP team, the service member, and leadership with objective expectations to assess risk. Certain jobs do not require certain physical demands as do others.
Marine Corps	Human Performance personnel such as Athletic Trainers, Strength Coaches, and Force Fitness Instructors. The responsible entity for implementing customized training regiments for new recruits, active duty and reserve forces would be Marine Corps Training and Education Command.

5. A determination of the feasibility of a customized fitness program for each warfighter to minimize musculoskeletal injuries during both home station and deployed status.

A comparison study between a control group and a group using force plate or similar technology would be needed to determine the feasibility of customized fitness programs to reduce MSK injuries (Table 5).

Table 5. Responses to Element 5 (determination of the feasibility of a customized fitness program for each warfighter to minimize musculoskeletal injuries during both home station and deployed status)

Air Force	This study could be completed without the use of FPT. The real question is whether FPT can add substantially to what a SME (e.g., strength coach) can provide with less expensive evaluations.
Army	Customized fitness programs that minimize MSK injuries at home station and deployed are feasible without force plate machine learning. Force plates are one tool among many to help with individualizing programs, but amateurs will not be able to use it effectively.
Navy	If you have the resources, manning, time allocated and equipment, a 5-minute jump profile can capture a wealth of information on the physical capabilities of the Service member. SME in strength and conditioning can use this assessment to design individual fitness programs around their strengths and weaknesses. A force plate with no SMEs, no follow up, and no individual programming would not be effective or feasible. A control group is critical for this. It is very likely that providing a well-designed strength and conditioning plan from a certified

	<p>strength coach will provide protective benefits from MSK injuries. There are many non-Force Plate tools to help facilitate the programming for the Service member to track progress and compliance.</p> <p>The individualization of training programs is feasible through the use of a combination of technologies that can potentially be used to set alerts for those who note large performance capability decreases and indicators of neuromuscular fatigue, of which that soldier's training program can be adjusted and relayed through other technologies.</p>
Marine Corps	<p>With technology the same or similar to FPML™, individualized and customized fitness programs to minimize MSK injuries, improve resiliency, and improve readiness are feasible, but limited by the capability of the force plate system.</p> <p>SMEs in the area of health, fitness, and strength training are necessary to develop a comprehensive and customized training program.</p>

6. The projected cost of employing this technology versus the cost of lost man days due to injuries or attrition.

There is currently not sufficient data to determine the cost savings of employing this or similar technologies.

7. The projected potential savings from injury avoidance.

There is not sufficient data to calculate projected potential savings from injury avoidance using this technology

D. CONCLUSIONS

The Military Services are currently examining tools and technologies, to include force plates, for use within the Military Services and across the DoD. This will require the development of proper procedures and methodologies to be followed through an evidence-based approach.¹ While research is needed, force plates and similar technologies can potentially serve as one tool within a portfolio that enables the Services to make informed programming and management decisions to protect and sustain the force and ensure combat readiness at the individual level through HP professionals.

¹ Merrigan, J. J., Stone, J. D., Thompson, A. G., Hornsby, W. G., & Hagen, J. A. (2020). Monitoring neuromuscular performance in military personnel. *International Journal of Environmental Research and Public Health*, 17(23), 9147