Department of the Navy SBIR/STTR Transition Program

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NAVAIR 2023-0068

Topic # N201-011
Minimization of Chronic Neck Pain in Military Aircrew and Vehicle Occupants
CFD Research Corporation

WHO

SYSCOM: NAVAIR

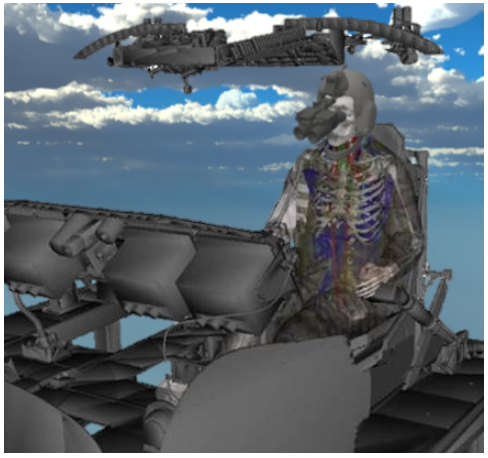
Sponsoring Program: PMA276

Transition Target: H-60 and fast jet tactical aircraft (e.g., F/A-18)

TPOC: (301) 342-9205

Other Transition Opportunities: Other rotary and fixed wing aircraft, fast boats, ground forces, occupational ergonomics and injury analysis in industry settings, commercial transportation (shipping, air, trucking)

Notes: The simulation framework contains tools that can generate neck models representing males and females of any anthropometry, then simulate those individuals performing in-flight head movements. CFD Research has also developed models of the shoulder, knee, and lumbar spine that can be utilized within the simulation framework. The Operational Neck Pain Index (ONPI) is currently live and continuously recording responses.



OpenSim musculoskeletal model with cervical spine musculature, seated in an H-60 cockpit and wearing a helmet with night vision goggles.

WHAT

Operational Need and Improvement: The computational simulation framework includes a detailed model of the neck (cervical spine) including full musculature that can be personalized for males and females of varying anthropometry. Simulations can be run with or without experimental data, facilitating theoretical investigations of new equipment or seating designs. The simulations are performed using the widely used open-source platform OpenSim, facilitating adoption across DoD agencies. The ONPI provides real-world data on incidence of chronic neck pain in pilots using an anonymized survey. Importantly, the ONPI gives detailed information on the location and type of pain, providing a basis for evidence-based interventions.

Specifications Required: Computational models and parametric simulations are required to determine potential contributors to acute and chronic operator neck pain and the specific pain mechanisms involved. Computational models should be structured such that recommendations toward improvements to seating (position, seat-back angle), helmet (weight and center of mass), and restraint systems (e.g., combined shoulder / lap belt), postures and operational guidelines are possible. The models should also be able to determine the predicted design(s) efficacy. A customized version of a pain rating scale is required due to their occupational challenges in military environment and the need for operational readiness.

Technology Developed: Cervical spine model in OpenSim; tools for applying accelerations (g-forces) during a simulation in OpenSim; algorithm to scale model strength to measured or published data; tool for scaling model to match any specified anthropometry for males or females; ability to import crewstation and seating geometry in OpenSim; Web-based ONPI survey

Warfighter Value: Flight crews represent a significant DoD investment of time, training, and financial resources. Enhanced understanding of the prevalence, location, type, and biomechanical causes of pain will lead to improved equipment design and operational guidelines for minimizing chronic pain and extending active duty flying career. In addition, acute pain-related medical issues in an individual aircrew member may compromise the battle-readiness of an entire squadron. Mitigating the underlying factors that result in pain can minimize downtime, increase readiness, and reduce medical costs for aircrews.

WHEN

Contract Number: N68335-22-C-0002 **Ending on:** Oct 16, 2023

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Initial cervical spine model in OpenSim 4	N/A		2	4th QTR FY21
Operational Neck Pain Index survey data analyzed	N/A		3	2nd QTR FY23
Muscle strength scaling of OpenSim model	N/A	Overall neck strength can be scaled to match measured values	3	2nd QTR FY23
Anthropometric scaling of OpenSim neck model	N/A	Male and female models with specified anthropometry can be generated for use in OpenSim	3	3rd QTR FY23
Parametric simulations with g-forces and head-worn equipment	Low	All simulation framework components utilized to simulate in-flight conditions	4	4th QTR FY23
If Option awarded, experimental validation using human subjects data	Medium	Collect experimental data from 10+ subjects and compare to simulations	5	4th QTR FY24
If follow-on funding awarded, utilize	Medium	Physical prototype created	6	4th

HOW

Projected Business Model: The musculoskeletal simulation framework and ONPI will be packaged into a Neck Loading Monitor product. The product will integrate with sensors such as inertial measurement units (IMUs) that can measure head and neck motion. The computational cervical spine modeling framework will be used to quantify neck loading and associate user biomechanics with self-reported pain through the ONPI. The product will be packaged as a software application and marketed to military and commercial organizations as well as individual consumers. An additional revenue stream is through expert consulting services to apply the tool to organization-specific scenarios and provide reports on the findings. These services would be intended to inform equipment design and operational guidelines for minimizing neck pain in military pilots and other occupations at high risk of chronic neck pain.

Company Objectives: Connect with organizations interested in addressing chronic neck pain in their workforce. Find a "champion" for this technology in the Navy or other armed forces.

Potential Commercial Applications: Tracking and monitoring of neck pain. Engineering design and acquisition decision applications across military operator platforms (air, land, sea) and military field use. Military or commercial vehicle drivers (air, shipping, trucking).

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