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Science and Technology (S&T) Plan for International Cooperative Engagement Program for Polar Research (ICE-PPR)

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Defence Research and Development Canada
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Canada

IMPORTANT INFORMATIVE STATEMENTS

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Abstract

The aim of the meeting was to introduce the participants to ICE-PPR, to familiarize them with each other's Polar Human Performance programs and similar efforts, and to identify opportunities for meaningful collaboration beyond information exchange.

Résumé

La réunion avait pour but d'initier les participants au programme d'action coopératif international en matière de recherche polaire (ICE-PPR), de les familiariser avec les programmes sur le rendement humain et polaire des autres participants et des efforts semblables et de cerner les possibilités de collaboration significative au-delà de l'échange de renseignements.

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Introduction

The first ICE-PPR meeting was held in the winter of 2016 in Helsinki, Finland, followed in succession by meetings in Yellowknife, Canada; Nuuk, Greenland; and Anchorage, United States of America (US). The earliest meetings were intended to yield a MOU amongst the participants, and a MOU is nearing completion and ratification by the participating nations. In Yellowknife, six lines of effort were identified; including four researches oriented working groups. The four working groups are "The Environment," led by the US, "Situational Awareness," led by Denmark, "Human Performance," led by Canada, and "Platforms," led by Finland. Collaborative field work began in 2017, when Canada, Denmark, and the US worked together to launch a small series of environmental monitoring buoys (AXIBs).

The first meeting of the ICE-PPR Human Performance Working Group (HPWG) was held 17 January 2018, at the DRDC – Toronto Research Centre. The ICE-PPR Workshop Schedule is included at Annex A. The HPWG meeting was preceded by an Arctic Human Effectiveness workshop in June 2017 in Ottawa, and immediately followed a workshop for the RCAF entitled "Polar Human Effectiveness," also held in Toronto. The outcomes of both workshops supported the HPWG meeting.

ICE-PPR HPWG participants included:

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8.	LCol Jay Nelles	jonathan.nelles@forces.gc.ca	1 CAD SSO SAR
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13.	Debbie Kemp	debbie.kemp@forces.gc.ca	DSTER
14.	Hilda-Ann Troupe	hilda-anne.troupe@forces.gc.ca	SJS J4 Nutrition
15.	Kari Kallinen	kari.kallinen@mil.fi	Finland

New Zealand's participation was attempted through teleconference but unsuccessful due time zone differences. The meeting was held in conjunction with, and immediately following, a workshop to develop "The Aviator" projects for the RCAF Surgeon, ALSE, SAR, and AE, and the briefings from that workshop directly influenced the outcomes of the ICE-PPR Polar Human Performance meeting.

Discussion

The meeting opened with a briefing by the Canadian ICE-PPR Action Officer, on ICE-PPR status and structure. It was followed by briefings on Canada's CAF (pan-military) and Canadian participation in NATO cold weather Arctic programs. The participants were then given a short tour of TRC, including the CETTS, diving chamber, and CANLEAP labs, before continuing with briefings from the USN, US Army, Finland, and Norway. The Norwegian representative noted that they were about to initiate a cold weather Human Performance program, the week of 6 February 2018. The briefings from the other participants are included in the Annex B.

Following the briefings, the participants identified areas of common interest for further research and collaboration, and in particular identified those problems which could be solved in short order with existing information and technology, those problems which could be further explored within 12–24 months, and those problems which were of interest to multiple participants but which would likely involve a longer term to develop a program and test plan, execute, analyze and report. The topics agreed upon for further investigation are:

1. Stoves: stoves for cooking and heating are the root cause of significant issues in Arctic operations. The components of the stoves are ordinarily metal, and often have small parts which cannot be manipulated by hand in gloves or mittens. The fuel is liquid and only some fuels remain liquid in the cold temperatures (-30 to -50 °C) observed in the Arctic. The soldiers and aviators have to remove the protective clothing on their hands to operate the stoves and manipulate the fuel. The fuel must be poured from one container to another, and is occasionally spilled with injurious effects on exposed flesh. This leads to freezing injuries, due to the cold and the spilled fuel. Once the stoves are lit, fumes are created which in confined spaces, such as a tent, lead to irritation of eyes, throat, and chest. Stoves designed for use in warmer zones, are often not efficient enough to heat water for cooking, in open air. The US is examining stoves which burn different fuel and which are more efficient, in the near term. It may also be possible to use different fuels, or design different stoves, for cooking and heating.

   Actions:

   a. US will report availability of latest US stove design to ICE-PPR participants, for possible evaluation in the Arctic exercise next year; and

   b. Canada will investigate new stove designs using alternate fuels.

2. Exercises: It was noted that different nations use different equipment and procedures, for apparently similar tasks. It should be possible to have small units operate together in one or a few exercises, using their own equipment and procedures, and compare performance and in particular, injury rates, between the different units, under constant conditions. EX TRIDENT JUNCTURE in autumn 2018 in Norway, NOREX and Op NUNALIVUT in 2019 in Canada, and potentially an exercise in Alaska in 2018 or 2019, will provide opportunities for section to platoon sized units to operate together in similar conditions, and for observations to be made. Subsequent exercise opportunities can be used to refine gross or qualitative observations, by introducing experimental and control groups and targeted instrumentation across the different ICE-PPR ensembles.

Actions:

a. ICE-PPR participants and in particular exercise participants will identify means to track injury types and rates in EX TRIDENT JUNCTURE, NOREX, and OP NUNALIVUT, and potentially an Alaskan exercise; and

b. Canada will arrange for participation of small units from each of the ICE-PPR nations, in NOREX and OP NUNALIVUT (2019), and issue an invitation to the nations to participate as desired, with their participants being equipped in their standard Arctic issue clothing and equipment.

3. Fabrics: Anecdotal, qualitative evidence is accumulating to indicate high quality wool is more effective as a base layer of clothing than cotton or synthetic fibres used to date. Other fibres, including caribou and qiviut, may be more effective still. Qiviut is reputed to be possibly two orders of magnitude more effective, but it is very expensive. Analysis of merino wool, caribou, and qiviut fibres could be undertaken to identify those characteristics which support their performance, and an effort to create a lower cost synthetic alternative could be undertaken.

   Action:

   Canada will identify a source of qiviut and caribou for analysis.[1] Canada and New Zealand will explore options to undertake comparative analysis of the natural fibres, and create a synthetic alternative at low cost.

4. Thermoregulation/Protection: Norwegian Olympic athletes train with devices which facilitate thermoregulation and protection, for example through heat exchange. Cross-country skiers breathe through a metal device which captures exhaled heat, and warms inhaled air, without unduly impairing breathing. Similar devices may be tailored to help soldiers or aircrew preserve heat. Norway will examine potential for adaptation of existing devices, or creation of new ones.

5. Cognition: Cognition can be impaired by diminished body temperature. At some point, impairment of cognition indicates a state of diminished body temperature, from which an individual is unlikely to recover without intervention. It may be possible to delay the onset of impairment, or preserve cognitive function, in the face of decreasing body temperature. This in turn could improve the chances of survival of aircrew awaiting rescue. Finland will consider leading a cognition study.

6. Nutrition: Nutrition contributes to survival, largely through ongoing, long-term attention to diet. It is possible that certain nutrients might provide incremental support to aircrew awaiting rescue in an Arctic winter. It was also noted that nutrition standards have not been reviewed and updated for an extended period. Simple emulation of indigenous people's diets has not been successful in the past, though there may be potential for incorporation of some aspects of those diets in either long-term nutrition or survival rations. Canada will consider leading a nutrition study.

[1] Caribou is widely available, but qiviut is not. Perhaps the best source of qiviut is from Cambridge Bay according to the Arctic College in Iqaluit, after the annual hunt. The animal hides and fibres are harvested and sold, in sufficient quantities to support a research program.

7. Dexterity: The ability to manipulate small objects such as on/off switches, or zippers, buttons, and other closure systems, or some tools, is critical to successful use of many of the components of most survival kits, including the seat pack from an ejection seat equipped aircraft such as the F18 aircraft used by Canada, the US, and Finland. However, injury frequently accompanies ejection, ditching/crash-landing, or bailout, limiting the dexterity of aircrew. Further, protective clothing such as mittens often must be removed to manipulate equipment, which in turn diminishes dexterity due to cold. Redesign of equipment to be more easily used by aircrew awaiting rescue in the Arctic, so that protective clothing need not be removed or not removed for so long, and so that it can be successfully used while injured (for example, using only the non-dominant arm and hand) might alleviate the problem. A redesign of protective clothing to facilitate dexterity without accelerating heat loss might also alleviate the problem. Finally, improving peripheral blood flow should also improve dexterity. Warming extremities without accelerating core heat loss, could help. Biofeedback techniques may be learned by individuals, to control peripheral blood flow and assist in maintaining dexterity and core temperature. Finland and Canada will coordinate to lead research in these areas.

8. Diagnosis and Treatment of Frostbite/Nip and other cold injuries: Diagnosis and treatment of cold injuries, including frostbite/nip, has not changed over several decades. Better means of diagnosing cold injuries, particularly in time to effectively reverse or treat injuries, are required. Improved treatment is also required, and for some injuries may have been developed in the UK. Canada will investigate further.

9. Local Knowledge / Indigenous Culture and Practices: Humans have been living successfully in the circumpolar regions for millennia. Even when similarly equipped, Canadian Rangers exhibit much lower injury rates than soldiers from the South, in the Arctic winter. A concerted effort to understand the practices of indigenous cultures, and apply local knowledge to military TTPs could yield improved effectiveness and diminish injury rates. The US will lead a project to better understand how the local populations survive and thrive, and identify practices applicable to military TTPs.

Conclusion

The Human Performance Working Group met and was successful in identifying a number of topics of common interest, across the participating nations. Lead nations were also identified, to further the specific areas associated with them. Canada will continue to coordinate the Human Performance Working Group. The next meeting of ICE-PPR principals will be in May 2018, at CRREL (Hanover, New Hampshire), in the US. The Canadian ICE-PPR AO will brief the principals on the HPWG plans and achievements to that point. Further work will continue, coordinated secretarially, until after the May 2018 meeting. The next meeting of the HPWG will be held in conjunction with the autumn 2018 ICE-PPR principals' meeting.

Figure 1: *RCAF Operations in the Arctic / Opérations de l'ARC dans l'Arctique.*

Annex A Workshop Schedule

Table A.1: *The following table summarizes the workshop timings.*

Day 3—January 2017		
TIME	**OBJECTIVE**	**FORMAT**
0900–0915	Introduction, Review	Facilitator led
0915–0930	ICE-PPR Overview	Vaughn Cosman
0930–0950	TRC Human Effectiveness—Arctic	Wendy S-K, LCol Natale
0950–1000	NATO 142 ET Update	Len Goodman
1000–1030	ICE-PPR FIN ARCTIC HUMAN PERFORMANCE PROGRAMS	Karl Kallinen
1030–1200	DRDC Lab Tour	Patrick Mason, Karl Freidl
LUNCH 1200–1300		
1300–1430	ICE-PPR US ARCTIC HUMAN PERFORMANCE PROGRAMS	
1430–1500	ICE-PPR NOR ARCTIC HUMAN PERFORMANCE PROGRAMS	Jan Ivar Kåsin
BREAK 1500–1515		
1515–1630	Group Discussion—Future Collaboration ICE-PPR	Facilitator led

Annex B PowerPoint Presentations

Finnish Defence Research Agengy

Human Performance Division

FINNISH ICE-PPR BRIEFING

Toronto 17.1.2018

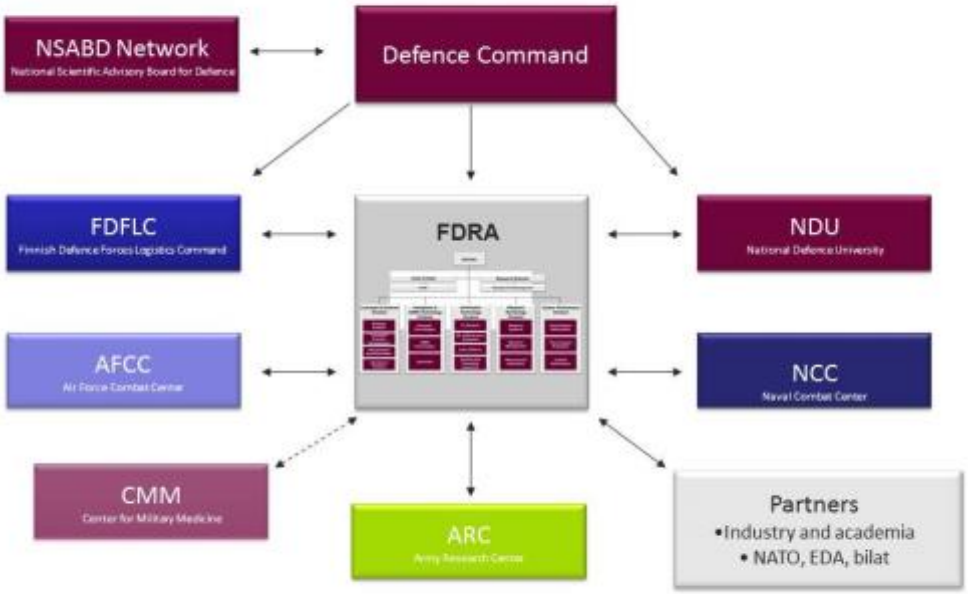
Kari Kallinen, PhD

Puolustusvoimat

Contents

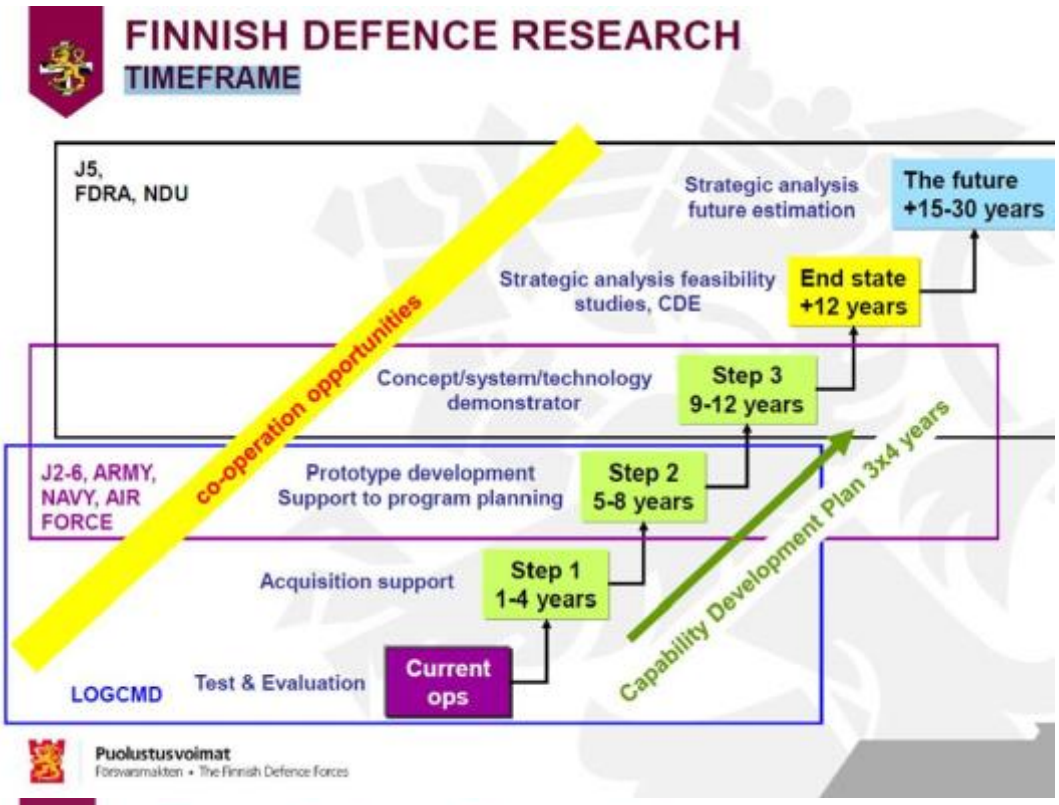
- Finnish defense S&T actors and responsibilities
- FDRA and national partners
- Recent cold studies
  - Army, Airforce, Navy
- Related projects
- Premilinary areas of interests for collaboration

S&T Actors in FDF



FDF S&T Responsibilities

	Concepts	Materiel	Personnel
DEFCOM	Supervision	Supervision	Supervision
FDRA	Strategic-operational level Common capabilities	Demanding research, testing and evaluation in all life cycle phases	Psychological and physical performance and testing
FDFLC	Operational level	Extensive test firings and field tests (in cooperation with FDRA and Services)	R&D related to military training, parts of physical testing
Army Navy Air Force	Tactical and combat level, experimentation	Field tests in all life cycle phases, test flights etc.	R&D related to military training and procedures
NDU	Basic research	Basic research	Basic research


FINNISH DEFENCE RESEARCH
TIMEFRAME
J5,
FDRA, NDU
Strategic analysis
future estimation
The future
+15-30 years
Strategic analysis feasibility
studies, CDE
End state
+12 years
co-operation opportunities
Concept/system/technology
demonstrator
Step 3
9-12 years
J2-6, ARMY,
NAVY, AIR
FORCE
Prototype development
Support to program planning
Step 2
5-8 years
Capability Development Plan 3x4 years
Acquisition support
Step 1
1-4 years
LOGCMD
Test & Evaluation
Current
ops
Puolustusvoimat
Försvarsmakten • The Finnish Defence Forces


Finnish Defense Research Agency
Director
Chief of Staff
Staff
Research Director
Research Management Unit
Concepts & Doctrine Division
Strategic Analysis
Concept &
OP ART
Operations Analysis
Energetic & CBRN Technology Division
Energetic Technologies
Laboratory
Information Technology Division
C2 Systems
RF Sensors &
Computing Laboratory
EW Systems
Weapons Technology Division
Weapons Systems
Laboratory
TECHNOLOGY
Human Performance Division
Psychosocial Performance
PERSONNEL
FDRA Human Performance Division

Human Performance Division

Research, test and evaluate to:

- Fit people to tasks and jobs
- Fit work environments and tools to the capasities of humans

Research groups

- Assesment and selection
- Surveys
- Warfighter performance
- Human Factors
- Human behavior and psychological operations

FDRA's National patners in cold research

Centre for Military Medicine

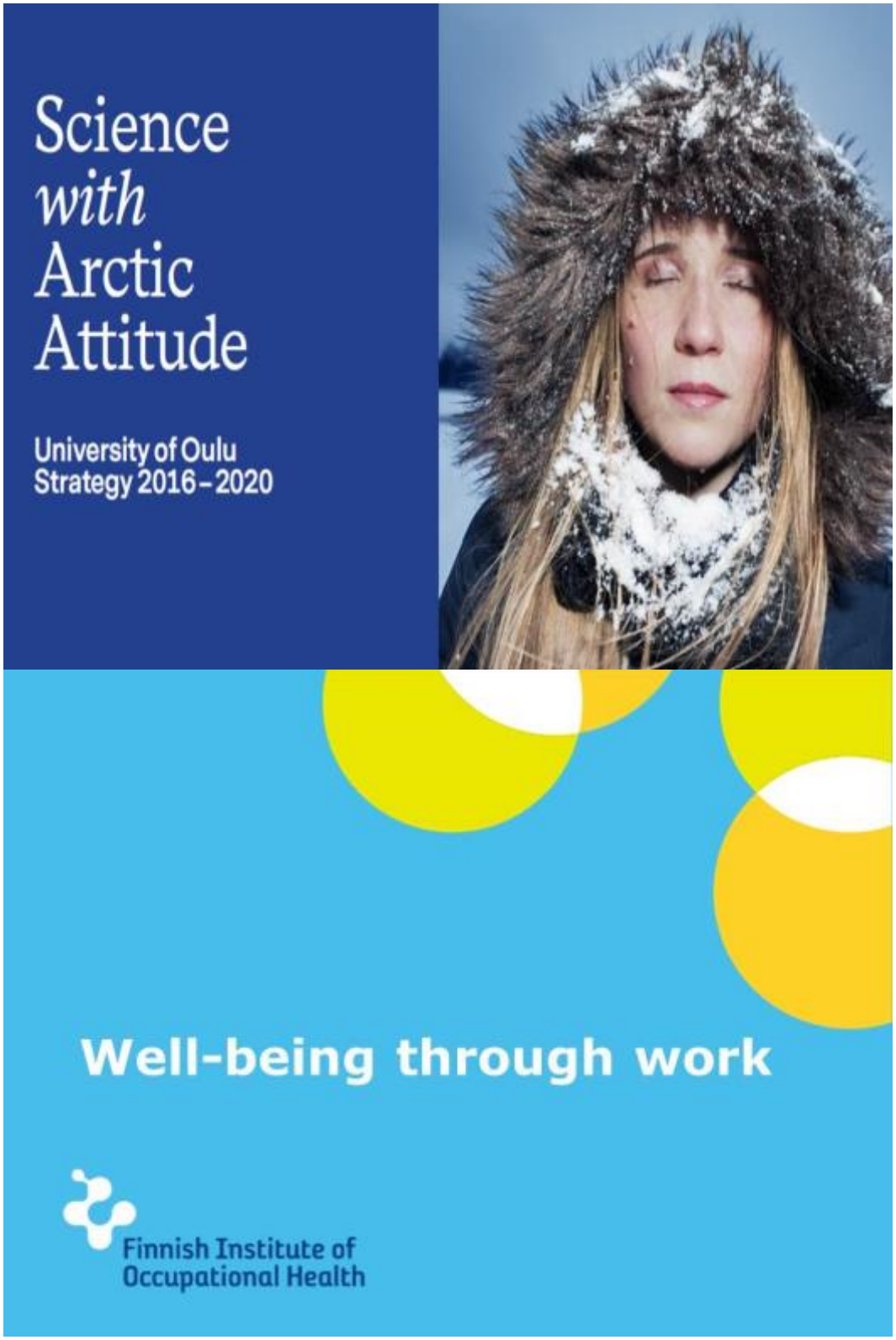
- Aero- and diving medical expertise
- Emergency medicine and Simulation
- Military Pharmacy

National Defense University

- Basic studies (master and doctoral thesis) on military technology, leadership and pedagogy

Universities, companies and research organisations

- University of OULU
- Institute of Occupational Health
- VTT Technical Reasearch Centre of Finland


Science
with
Arctic
Attitude
University of Oulu
Strategy 2016 – 2020
Well-being through work
Finnish Institute of
Occupational Health

VTT
TECHNICAL RESEARCH CENTRE OF FINLAND

The leading research and technology company in the Nordic countries. VTT has a national mandate in Finland. Provides expert services for domestic and international customers and partners. Serve both private and public sectors.

- **Turnover** 277 M€, **personnel** 2,600
- **Key technology areas**
  - Applied materials
  - Bio- and chemical processes
  - Energy
  - Information and communication technologies
  - Industrial systems
  - Microtechnologies and electronics
  - Services and the built environment
  - Business and innovation research

Results
- notifications of inventions 316
- over 1,200 patents and patent applications in VTT's patent portfolio
- publications 1,465
- scientific articles 652 (44 %)

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Försvarsmakten • The Finnish Defence Forces

Recent projects

Soldier in cold

- Finnish Defence Forces and Institute of Occupational Health 2003-2007
  - Research on long-term winter exercises
  - Evaluation and measurement tools to assess soldier performance and workload in winter conditions
- HFM-168 Symposium on SOLDIERS IN COLD ENVIRONMENT 2009 in Helsinki
  - Sessions on field medicine, cold physiology, protection against cold, physical and mental performance, fluid balance and nutrition

Soldier in cold

- Arctic seminar 2014 in Sodankylä
  - Update information about equipment requirements and training for winter conditions
- Ongoing constantly running ARMY project "Fighting in cold"
  - Analysis of nearby regions and Finnish defense capabilities
  - Recommendations to improve tactics, operations and equipments

Jaeger Brigade centre of winter warfare

- Training for regional troops specialised in the demanding conditions of Lapland, as well as national air defense troops and Border Guard troops

- Winter warfare
- SERE (Survive, Evade, Resistance, Extraction)

AIRFORCE SERE CONCEPT

SERE

Survival, Evasion, Resistance, and Extraction (SERE)

- Defines set of tactics, techniques, and procedures that will give isolated personnel tools to survive in any environment and to evade capture where such threat exists. Failing that, to resist exploitation by captors and, if the situation permits, escape captivity to finally support their own or assisted recovery and return with dignity.
- Conduct After Captured (CAC) is included in our SERE concept

Tactics, techniques, and procedures (TTPs) in Cold Conditions 1 (Peace Time)

- Use only operational flight equipment
- Wear flight equipment according to season
- Wear territorial flight equipment
- Layering (underwear, mid-wear, buf, sleeves to life vest)
- Hydrate yourself
- Avoid sweating during brief/walk
- Consider ventilation of flight equipment
- Ask if you are in doubt or not sure, your superior will guide you

TTPs in Cold Conditions 2 (Peace Time)

- Prepare youself mentally to get "cold"
- Review mental drills during ejection (to ensure your functional capability)
- Review survival equipment (that will be useful to sustain your functional capability)
- Review how to make best shelter against cold weather by using protection of snow, life raft, and your equipment
- Distress calls (air/ground/water)
- If you are in water -> asap to life raft
- PLB will not activate automatically – you have to do it yourself to ensure quick rescue (by ARFF or civilian authority)
- Stay tranquil – do your best and ARFF (Aircraft Rescue and Fire Fighting) team will do its job

FORA Human Performance Division

TTPs in Cold Conditions 3 (Peace Time)

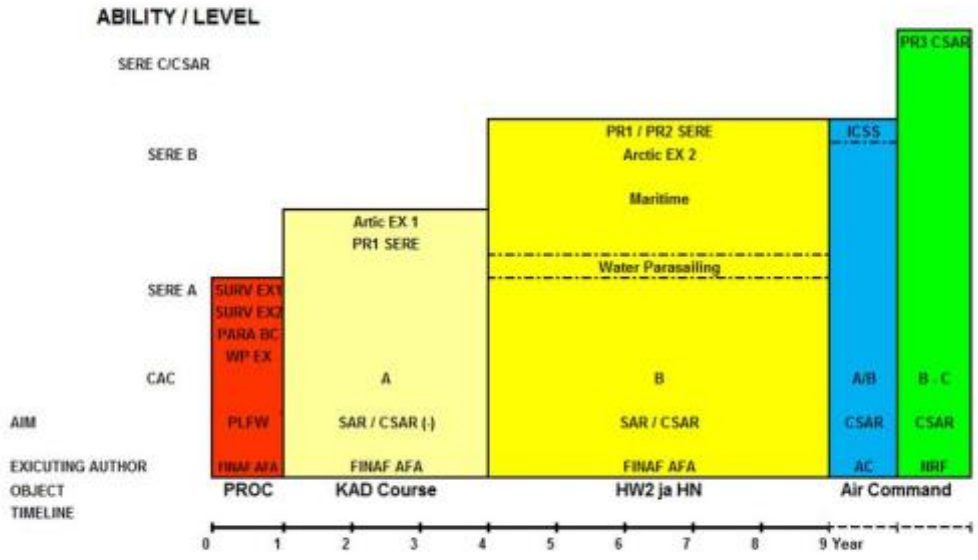
- Check your condition/damages
- First aid (medical kit)
- Make yourself visible (fire, also for warmth)
- Don all protective wear (hands and feet)
- Cook water
- Do not move / evade (if you do not know your location / too much snow, darkness)
- Communicate/authenticate (fire, buzzaw, MS 2000, PLB, cell)
- Think positive

FORA Human Performance Division

SERE Training Levels (FINAF)

- Level A
  - Minimum basic level
  - Introduces potential isolated personnel to concepts of SERE operations, policy, and doctrine
  - Pilot Reserve Office Course / lectures
- Level B
  - Intermediate level of SERE academic and application training, specifically for those personnel identified by nations at moderate risk of capture and explotation.
  - National Defence University / theatre / applied exercise
- Level C
  - Advanced level of SERE academic and application training, specifically for those personnel identified by nations at high risk of capture and exploitation.
  - According threaths -> advanced training according to environment (expected in planned operation area)

Education and Training (Flow)



Air Force

Military Pilots in Cold Conditions - Sustaining Functional Capability

- Airforce task is to monitor and secure Finland's territorial integrity
- 62 Boeing F/A-18C and F/A-18D Hornet multi-role fighters

Air Force

The Mid-Life Upgrade 1 (MLU 1) and 2 (MLU2)

- Maintaining and improving the aircraft's air-to-air capability
- Providing air-to-ground capability

→ Capability of accomplishing its operations safely and reliably till the 2020s (F-18 will be replaced new fighters 2030)

→ No new capabilities; only procurement of spare parts, structural reinforcements and engine overhauls

HX Fighter Program is aiming to replace the operational capability of the Air Force F/A-18 aircraft, which will be decommissioned as of 2025, with multi-role fighters

Options for replacing Hornets

- Boeing F/A-18 Super Hornet (United States)
- Dassault Rafale (France)
- Eurofighter Typhoon (UK)
- Lockheed Martin F-35 (United States)
- Saab Gripen (Sweden)

Next major need for research on human effectiveness and cold will be after the decision of the fighter has been made

Current flying equipment

- Flying equipment (summer/winter and immersion suit, G-pants, life west)
- Changeable according to weather/seasonal conditions
- Flight gear is outermost layer against weather conditions in ejection
- Immersion suit only mid-layer, needs insulation on inside
  - Not breathable (reduced physical comfort)


Survival Equipment in Life Vest
Survival Kit
FORA Human Performance Division
27


Parachute and Life Raft (for shelter and protection)
Parachute (T 10) is placed on top of seat
Life raft (LRU 23 P) is placed under seat (in top of survival kit)

NAVY: Diving in cold

- Effects of dehydration, suit insulation, closed circuit diving apparatus and thermal warming systems on diver's thermal balance and prevention of hypothermia
- Conducted by Naval Academy
- Latest report:
  - Comparison of Argon and Air as Thermal Insulation Gases in Dry Suit Dives during Military Arctic Diving Equipment Development Tests

Other projects

- Supporting soldier recovery after and during demanding operations with active psychological interventions (debriefing, relaxation and breathing techniques, mindfulness excercises)
- Supporting mental performance with training
- FDF research program project "Warfighter performance" (using biomonitoring to assess physical and cognitive performance and to enhance decision making)
- Sitational awareness and workload during multitasking
- Human enhancement
- Human unmanned/automomous system teaming

Premilinary areas of interest for collaboration

- Hx or nextgen multirole fighter implications to pilot requirements and assesment
- Hx or nextgen multirole fighter implications to ALSE
- Psychophysiological correlates to hypoxia

(SERE):

- Soldier monitoring
- Cognitive performance in cold
- Mental training techniques in improving performance in cold (relaxation and breathing, mindfulness etc.)

Thank you for your attention

kari.kallinen@mil.fi

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Physiological Monitoring to Enhance Military Performance

Karl E. Friedl, PhD, COL(Ret)
Senior Research Scientist, Physiology (Performance)
U.S. Army Research Institute of Environmental Medicine
Natick, Massachusetts 01760-5007

International Cooperative Engagement Program for Polar Research
DRDC, Toronto, Canada
16-18 January 2018

Unclassified

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There can only be one!

Performance algorithms switch to medical triage algorithms, using the same physiological sensing system

Soldier/commander applications **Medic applications**

Concept: Fred Hegge ca.1996; LtCol Stephan Rudski, 2001

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Leader/soldier needs

Only Important and Actionable Information

Thermal-Work Strain

Need to know when a soldier is reaching limits of work performance in the heat

Alertness/fitness for duty

Need to know when a soldier's attention is lapsing with microsleeps and reduced situational awareness

Musculoskeletal fatigue

Need to know who is beginning to fail in loaded road marches and patrols

Neuropsychological

Need to know who may be in distress based on changes in mood, cognition, and stress levels

Physiological responses in specialized environments

Need to identify early signs of incapacitation from exposures such as cold and hypoxia in mountain operations, and severe air pollution in dense urban environments to implement protective measures

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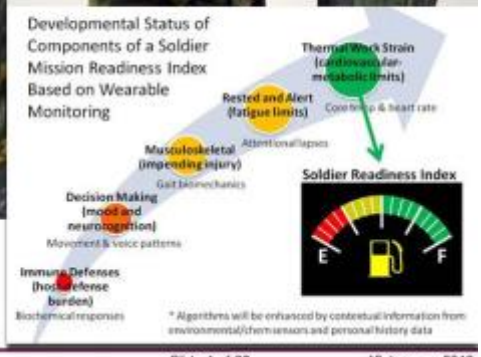
Data Management

A single soldier readiness score that can be further queried



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What is the use case?

Are these most useful in training (and can be dispensed with in operational missions)?

Does this added burden provide enough advantage to a well-trained self-aware soldier or athlete?

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Leader/soldier needs

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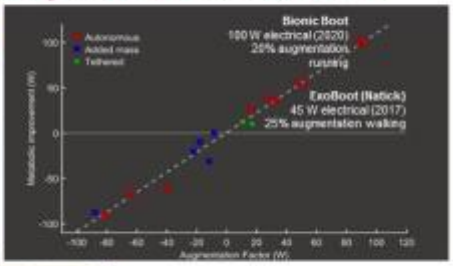
Biomechatronics

Exoskeleton: enhanced mobility with powered boot

Hugh Herr, MIT



An ankle joint exoskeleton (powered boot) provides untethered mobility enhancement with substantial reduction in energy costs

NextGen: biomechanical sensing and optogenetic muscle stimulation

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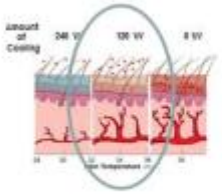
RT-PSM will drive soldier smart microclimate systems

- *Microclimate cooling using skin temperature feedback can reduce power requirements by ~50%*
- *Doubling effective conductive surface area with new nanotechnology fibers further enhances thermal exchange*

Allowing T_{sk} to fluctuate between 33-35° C provides optimal cooling



Efficacy of intermittent, regional microclimate cooling

Samuel N. Cheuvront, Margaret A. Kolka, Bruce S. Cadarette, Scott J. Montain, and Michael N. Sawka

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Stress Management

Smart phone camera for heart rate variability biofeedback

Carmen Russoniello
East Carolina State University

Russoniello et al. Cyberpsychology, Behav Soc Networking 2013;16:302-308

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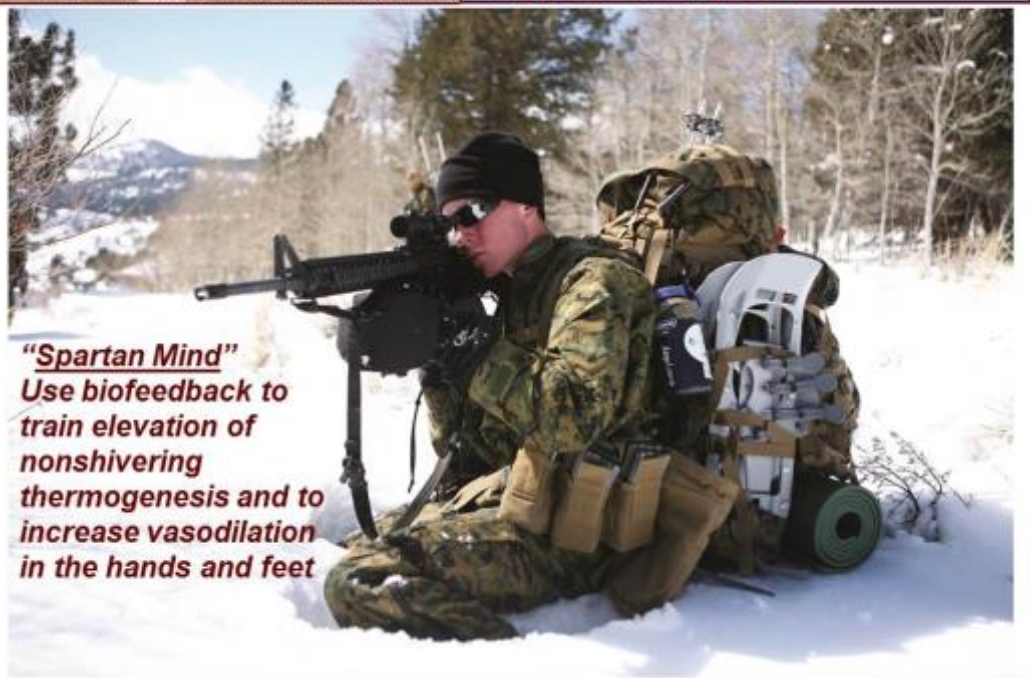
Enhance performance in extreme conditions



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Components of a PSM system

Physiological status monitoring

Source: Reed Hoyt (USARIEM) and Jeffrey Palmer (MIT Lincoln Labs)

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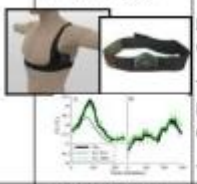
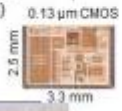
Technology Development

Reed Hoyt
USARIEM

Jeff Palmer
MIT Lincoln Lab

RT-PSM capability development path

	Baseline	Near-term	Mid-term
Technology	Hidalgo/Zephyr 	RT-PSM Low SWaP GOTS/mod COTS Tunable Narrow Band (TNB)(low data rate) Ti11xx 	ULPW-SoC PSM Batteryless, power harvesting, integrated sense/process/ communicate (UWB/TNB) 
TRL (current/planned)	TRL 7-8 (COTS)	TRL 4-6	TRL 3-6
Applications			
1. Specialized 2. Training 3. Operational	*Specialized*	*Training*	*Operational*

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Convergence Science

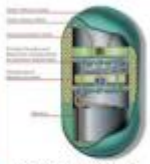
Wearable monitoring requires a partnership between physiology and engineering

Technology Development

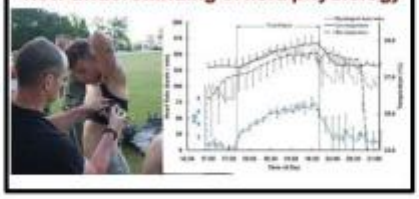
Physiological Discovery

Science fiction & commercial devices

New sensor technologies



New understanding of field physiology



Useful military applications

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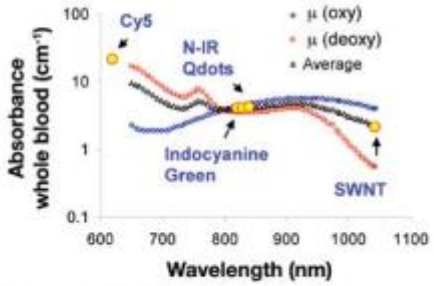
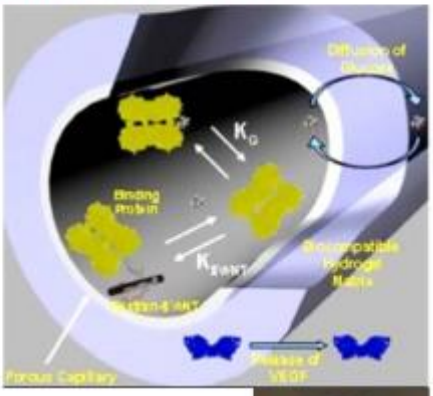
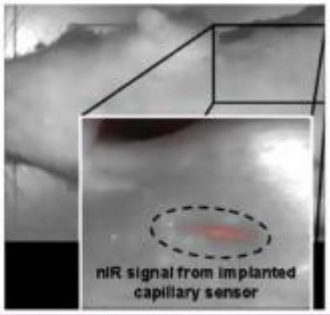
Implantables are coming

Measure glucose in a subcutaneous "tattoo"







Single wall nanotube (SWNT) glucose sensors

Barone & Strano
J Diabetes Sci Technol 2009;3:242

Michael Strano, MIT

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Body powered RT-PSM system

Advanced Phase System-on-a-Chip Performance Monitoring System

NSF ASSIST program

Veena Misra

ASSIST program, North Carolina State University

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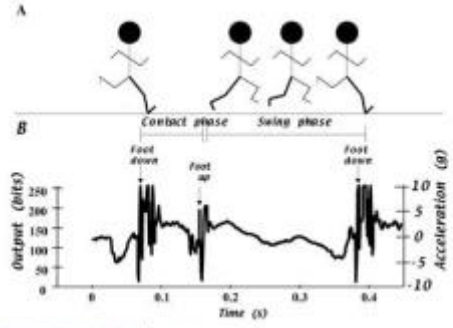
Estimating metabolic costs

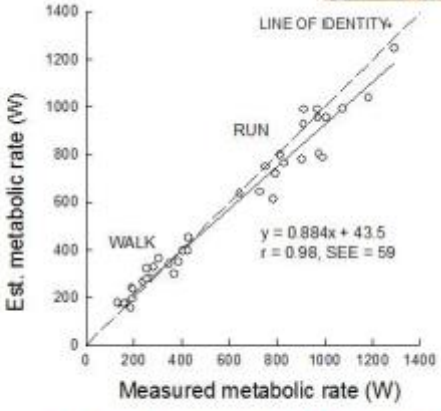
Foot Strike Monitor: Metabolic cost of locomotion

$M_{loco} = f$ ([body wt + load wt]/accelerometric Tc)



Pedometry can be used to differentiate inactivity, NEAT, and locomotory activity

Reed Hoyt, USARIEM



J Appl Physiol 1994;76:1818

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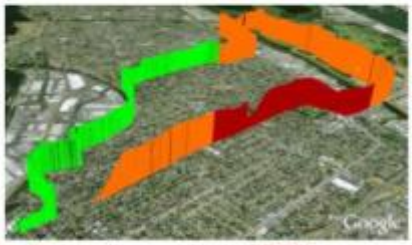
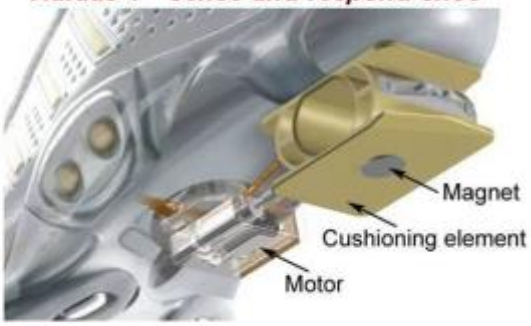
Sensing fatigue



Example course and RPE scores

"Adidas 1" sense-and-respond shoe



Classification of Perceived Running Fatigue in Digital Sports

- Stride sensor & chest strap : running speed, stride frequency, barometric height, HR and RR-interval
- Smart shoe: continuously measured heel compression
- Cell phone with a custom-built Java software: played sound files, recorded answers related to perceived fatigue questions, and gathered GPS information

https://www.researchgate.net/publication/220928261

Bjoern Eskofier, FAU

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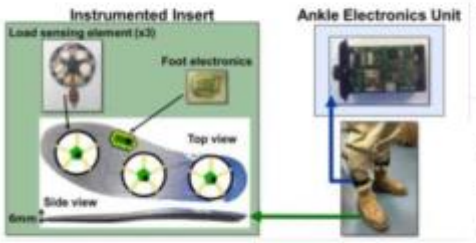
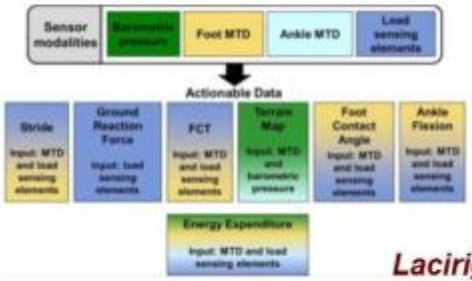
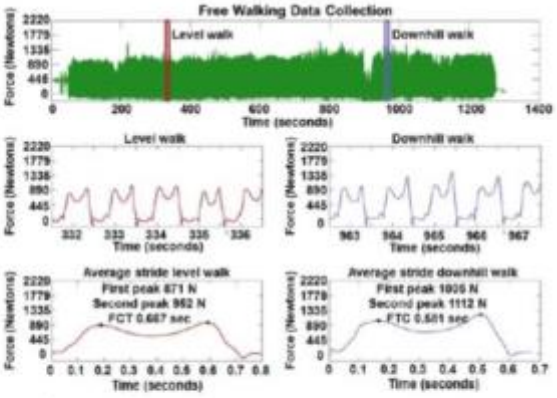
Instrumented footwear systems





Instrumented Footwear Inserts: A New Tool For Measuring Forces and Biomechanical State Changes During Dynamic Movements*

Joseph Lacirignola, Christine Weston, Kate Byrd, Erik Metzger, Nineshka Singh, Shakti Davis, David Maurer, Whitney Young, Paula Collins, James Balcius, Mark Richter, Jeff Palmer, *Member, IEEE*



Lacirignola et al.
IEEE Body Sensor Networks 2017

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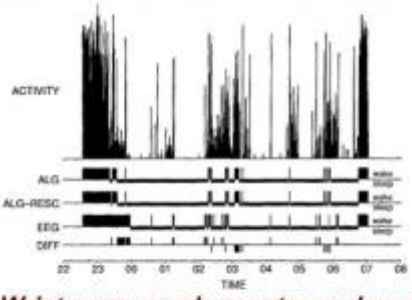
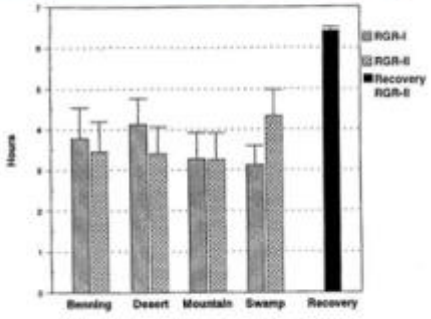
Field sleep studies



Wrist-worn accelerometry analyzed with the Cole-Kripke algorithm has ~90% agreement with PSG



Moore et al. 1992; Shippee et al. 1994

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You can sleep after the mission!

Taking polysomnography "lite" to the field for vigilance status monitoring

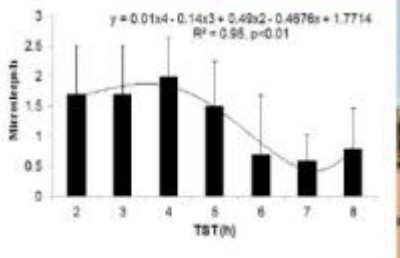
In-Flight Automatic Detection of Vigilance States Using a Single EEG Channel

F. Sauvet*, C. Bougard, M. Coroenne, L. Lely, P. Van Beers, M. Elbaz, M. Guillard, D. Léger, and M. Chennaoui

Body Sensor Networks Conference, Eindhoven, The Netherlands, May 9-12, 2017

Fabien Sauvet
IRBA

IMPROVEMENT OF EEG SIGNAL RECORDING WITH MINIATURIZED RECORDER : DEVELOPMENT OF SPECIFIC INTERFACE AND SOFTWARE



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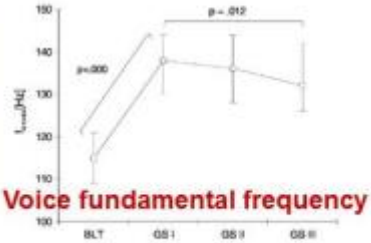
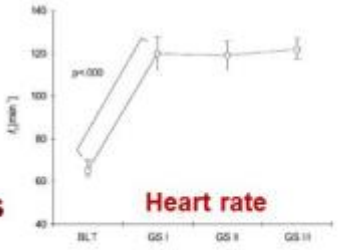
Voice Stress Analysis

Monitoring emotional status
Physiological signals to assess stress coping

Commando training - guerilla slide



Voice fundamental frequency



Heart rate

Distinguishing distress and eustress
Bernd Johannes & Peter Wittels

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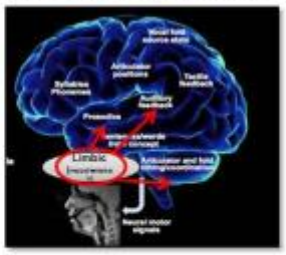
Speech elements as stress biomarkers

Modulation of Speech by Depression

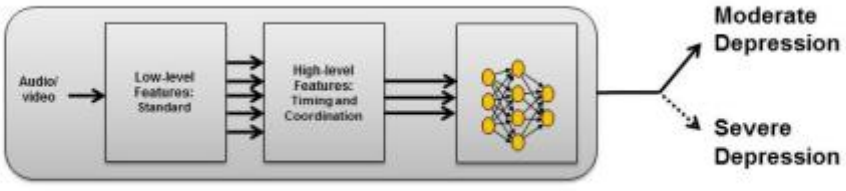
Modulation of Core Speech Network



Thomas Quatieri
MIT Lincoln Lab

Hypothesis
Depression disrupts the limbic system modifying core production regions required for precise timing and coordination between articulators

Detecting a Neurological Condition



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Virtual human "SimSensei"

Detection and Computational Analysis of Psychological Signals (DCAPS)

DARPA

USC ICT
INSTITUTE FOR CREATIVE TECHNOLOGIES

Russ Shilling, PhD, CAPT(ret)

Capture and comprehend communication clues to better understand people's emotional states

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Affective Computing

Virtual empaths: a trusted emotion-sensing avatar for every soldier?

http://ict.usc.edu/prototypes/simsensei/

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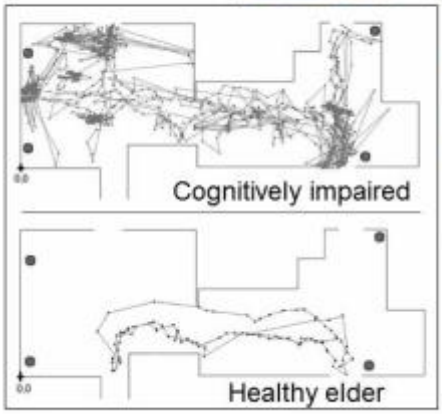
Movement patterns as neurocognitive biomarkers

Tortuosity in Movement Paths Is Related to Cognitive Impairment

Wireless Fractal Estimation in Assisted Living Facility Residents

W. D. Kearns[1]; V. O. Nams[2]; J. L. Fozard[3]
[1]Department of Aging and Mental Health, Louis de la Parte Florida Mental Health Institute, College of Behavioral and Community Sciences, University of South Florida, Tampa, FL, USA;
[2]Department of environmental Sciences, Nova Scotia Agricultural College, Truro, Nova Scotia, Canada;
[3]School of Aging Studies, College of Behavioral and Community Sciences, University of South Florida, Tampa, FL, USA



Keywords
Cognitive impairment, dementia, wandering, tracking technology, path tortuosity

Summary
Background: Using traditional assessment procedures, prior research demonstrated that deficiencies in gait and balance occur in the later stages of dementia.

going to a dining area, conversing and watching television. Transponder location was updated at 0.4 sec intervals while in motion and revealed large individual differences in activity patterns.
Results: Fractal dimension (Fractal D), a measure of movement path tortuosity (directed vs. irregular or apparently aimless locomotion) was significantly and negatively cor-

Movement Path Tortuosity in Free Ambulation: Relationships to Age and Brain Disease

William Diehl Kearns, James Leonard Fozard, and Vita O. Nams

mentia over time as tortuosity levels slowly increased.
Methods: An ultra-wideband sensor network

status have necessarily controlled various components of gait. The present results demonstrate that directional changes and other

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Shared sensing – "Brain-net"

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Current research path

By 2025, implement technologies currently in development

By 2040, implement technologies based on currently known science

Initial system
Wear-and-forget noninvasive

Objective system
Body powered implantable

Future Gen system
Brain-to-brain sensing

Internet of Things
Contextually Rich Predictions

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Soldier Performance Research

Military Biomedical Research Partners

Australian Government
Department of Defence
Science and Technology

JYVÄSKYLÄN YLIOPISTO
UNIVERSITY OF JYVÄSKYLÄ

DEFENCE R&D DÉFENSE

USARIEM

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Bundesamt für Sport BASPO

tgtf

DSO NATIONAL LABORATORIES

FFI Forsvarets forskningsinstitutt
Norwegian Defence Research Establishment

OFFICE OF NAVAL RESEARCH GLOBAL

ICE-PPR- National Principals Meetings

- 1 – Helsinki, Finland
- 2 – Yellowknife, Canada
- 3 – Nuuk, Greenland
- 4 – Anchorage, USA

- *ICE-PPR Fifth Principals' Meeting*
  - *– New Zealand to host*

ICE-PPR Working Groups

Working Groups		Planned Technical SME Meeting (e.g. VTC)	Identified Potential Project(s)
Topic Areas	WG National Leads		
Situational Awareness	**Lead Nation: DEN** CAN DEN FIN ISL NOR NZL SWE US- Dr.. Scott Harper (ONR)		

- Model-Based Systems-of Systems Surveillance Network Architecture Design and Assessment
- Workshop on "Gray-Zone" Mitigation Approaches in Polar Regions
- Demo
  - US-led Arctic Mobile Observatory System (AMOS) in 2019
- Nano/micro/cube satellite cooperation
- Communication system cooperation
  - Mesh networks (US)

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ICE-PPR Working Groups

Working Groups		Planned Technical SME Meeting (e.g. VTC)	Identified Potential Project(s)
Topic Areas	WG National Leads		
Human Performance	**Lead Nation: CAN** CAN DEN FIN ISL NOR NZL SWE US- Dr. Tim Bentley (ONR)		

- Workshop on Human Performance in Polar Environments (CAN has offered to host)
  - Mounted (in vehicles) and dismounted (not) aspects in cold weather
- FIN-SWE (NORDEFCO) Cold Weather Diving Study
  - Follow-on research opportunities
- Decision Support Systems

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ICE-PPR Working Groups

Working Groups		Planned Technical SME Meeting (e.g. VTC)	Identified Potential Project(s)
Topic Areas	WG National Leads		
Platforms	**Lead Nation: FIN** CAN DEN FIN ISL NOR NZL SWE US- Dr. Tom Fu (ONR)		

- US –led Workshop on Power and Energy (microgrids) for remote locations
  - Civilian and military capability needs and technical approaches
- De-icing and icephobic approaches
- Design approaches for surface platforms, particularly unmanned vehicles
- Unattended Platforms/Sensors in the Polar Environment
- Platforms with availability for sensor deployment

ICE-PPR Working Groups

Working Groups		Planned Technical SME Meeting (e.g. VTC)	Identified Potential Project(s)
Topic Areas	WG National Leads		
The Environment	**Lead Nation: US** CAN DEN FIN ISL NOR NZL SWE US- CDR Blake McBride (ONR)		

- Data Collection for Multiple Arctic Regions during the Year of Polar Prediction (YOPP, 2017-2019)
- Use of Arctic environmental dataset for comparison and improvement of modeling approaches- Tools and Simulation Development
  - Circumpolar Waves and wave-sea ice interactions
  - Acoustic propagation (e.g. approaches for signal processing and synthetic training)
  - Electromagnetic Noise Levels (MCM)
  - Ice dynamics (e.g. Glaciers, Antarctic vs Arctic, sea-ice)
- Experiment to track icebergs (RADAR-Sat and Shore Based and AIS on Icebergs)
- Charting and Surveying in Arctic Regions

Working Groups		Planned Technical SME Meeting (e.g. VTC)	Identified Potential Project(s)
Topic Areas	WG National Leads		
Experimentation, Demonstrations, and Exercises **Research Facilities** **Personnel Exchanges**	**Lead Nation: CAN** CAN DEN FIN ISL NOR NZL SWE US- CDR Kelly Taylor (TFCC)		

- Repository of information (provided by nations, CAN to host portal- limited access)
  - Demos and Exercises (opportunities for technology, and technology looking for deployment help)
  - R&D Facilities (opportunities for testing, and technology looking for testing)
  - Personnel Exchange (placement opportunities, looking for placements)

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Working Groups		Planned Technical SME Meeting (e.g. VTC)	Identified Potential Project(s)
Topic Areas	WG National Leads		
Technical Topic Information Repository	**Lead Nation: CAN** DEN FIN ISL NOR NZL SWE US		

- Technical Topic Information Repository
  - Architecture provided by CAN
  - Self populated by nations
  - Examples
    - CAN to share Arctic Security Architecture Study
    - FIN-SWE Cold Weather Diving Study

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WG Activity 2017, 2018 & 2019

- 2017 – AXIB Drops (CA, DK, US)
- 2018 – Environmental WG (Stennis, MS)
  AXIB Drops (CA, DK, US)
  Surveillance site recce (CA, DK)
  CREL Workshop (all)
- 2019 - AXIB Drops (CA, DK, US)
  Surveillance System trial
- 2020 - JAE 20

Questions?

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4. AUTHORS (Last name, followed by initials – ranks, titles, etc., not to be used)

Cosman, V.; Sullivan-Kwantes, W.; Fung, J.

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Reference Document

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ICE-PPR; ALSE; Aviator

13. ABSTRACT (When available in the document, the French version of the abstract must be included here.)

The aim of the meeting was to introduce the participants to ICE-PPR, to familiarize them with each other's Polar Human Performance programs and similar efforts, and to identify opportunities for meaningful collaboration beyond information exchange.

La réunion avait pour but d'initier les participants au programme d'action coopératif international en matière de recherche polaire (ICE-PPR), de les familiariser avec les programmes sur le rendement humain et polaire des autres participants et des efforts semblables et de cerner les possibilités de collaboration significative au-delà de l'échange de renseignements.