



HAL
open science

Virtual environment design as automated "physiological" counter-measures in extreme environment: from intensive care to human space flight.

Didier Fass, Bruno Levy, Pierre Perez, Dominique Méry

► To cite this version:

Didier Fass, Bruno Levy, Pierre Perez, Dominique Méry. Virtual environment design as automated "physiological" counter-measures in extreme environment: from intensive care to human space flight.. AHFE 2018 - Human Factors and Simulation, Jul 2018, Orlando, United States. hal-03198564

HAL Id: hal-03198564

<https://hal.science/hal-03198564v1>

Submitted on 14 Apr 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Title: Virtual environment design as automated "physiological" counter-measures in extreme environment: from intensive care to human space flight.

Authors: Didier FASS ⁽¹⁾, Bruno LÉVY ⁽²⁾, Pierre PEREZ ⁽²⁾, Dominique MÉRY ⁽³⁾

(1) ICN Business School and Mosel Loria UMR CNRS 7503, University of Lorraine.

(2) Service de Réanimation Médicale Brabois, CHRU Nancy, Pôle Cardio-Médico-Chirurgical, 54511 Vandoeuvre-les-Nancy, France ; INSERM U1116, Faculté de Médecine, 54511 Vandoeuvre-les-Nancy, France ; Université de Lorraine, 54000 Nancy, France.

(3) TELCOM Nancy and Mosel Loria UMR CNRS 7503, University of Lorraine.

How can we model and design virtual environments to prevent, monitor and avoid automatically major human factors and health issues after intensive care long stay and long-term space flight?

Intensive care unit (ICU) and long-term space flight are extreme environments. In both cases it is a risky journey for patients or astronauts that requires life support systems to maintain and protect body integrity, vital functions, sensorimotor and cognitive capacity as stable as possible for post-ICU quality of life recovering or for human outer planet exploration.

To send and make a human living and acting in space, the problem is sensibly different. It is no longer a question of survival but of extension of the domain of life and activity of the person that requires specific life and activity support systems. Artefacts, transport and life modules, and wearable devices (astronaut suits) must be designed in order to maintain: body integrity and physiological functions; sensorimotor and cognitive functions, and the operational capacity of the operator in situation; the physiological functions of the operator in a functional area compatible with the return to planet gravity (different on earth, moon or mars) by avoiding for example the risk of cardiovascular collapse or a transient sensorimotor disability.

Designing reliable, safe and adaptable human-machine in intensive care for every person with a major disease is a challenge for automated monitoring, decision-making and medical treatment to maintain the patient alive and allow healing on one side and to avoid complications due to prolonged stay in intensive care. For example both long-bed rest in resuscitation and the absence of gravity during long-term space flights cause neuromuscular deconditioning and loss of muscle strength.

To prevent and avoid complications related to long-term stay in these extreme environment, related to human factors and habitability element as bed rest, sound and light environment, medical treatment side-effects in ICU, food or weightlessness and life support systems design, we propose the use of multimodal virtual environment as "physiological" counter-measures and monitoring system.

The challenge of these human-system automated body enhancement system, is not so much a question of human-machine communication as of integrating the whole human machine into a coherent system ensuring functional capacity and limiting dysfunctions evolution either directly, either by countermeasure or substitution. It is a question of modelling and simulation correctness. From evidence-based medicine to model-based engineering it is a safety and reliability by design challenge.