

SPACE LIFE SCIENCES SYMPOSIUM (A1)
Multidisciplinary Space Life Sciences Research (8)

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SPACE FOOTWEAR: A NEW TYPE OF FOOTWEAR TO COUNTERACT MICROGRAVITY
PROBLEMS**Abstract**

Living in microgravity onboard the International Space Station, astronauts have great problems with the lower part of their bodies, particularly their legs and feet. As described both by NASA research and by research done at Politecnico di Milano (Ferrari, 2004; Whitmore et al. 2011), the main problems here are twofold: barefoot instrument interaction and the physiological effects of microgravity on the legs. Until now, the adaptation of earthly shoe models for space utilization has turned out to be inappropriate, uncomfortable, and difficult to wear in microgravity. Without adequate footwear, the astronauts work and live barefooted. One problem is that bare feet are used in restraints to maintain a still posture while working, and that these restraints are not made for being used with bare feet. As a consequence, they are reported to be uncomfortable to use, and after long use may also lead to pain on the bare feet. Another problem is related to the physiological reactions caused by microgravity. These are muscle and tactile atrophy, upper shift of the body liquid, problems with the cardiovascular system, and bone demineralization. Today the countermeasures applied are not fully efficient, and after long duration missions, the effects are so strong that astronauts have serious difficulties such as staying upright. The Isao Hosoe design studio in cooperation with the Extreme Design research group is proposing a new type of footwear that is able to overcome these problems. The concept envisions protecting the foot from the restraint with light and easy-to-wear footwear, while at the same time simulating the effect of walking on earth and reestablishing the sensitivity of the feet. The footwear is equipped with a special mechanism of elastic fibers that, through small movements of the ankle joint, is able to massage the soles of the feet and thus stimulate blood circulation and muscle reaction. This kind of stimulus has positive effects on the entire organism; indeed, as the oriental culture explains, "the foot is the second heart" . The footwear is also useful in many other isolation contexts where the user is not able to walk for a long time, such as in hospitals or during long intercontinental flights, for example. In the paper, the research results as well as the final application tested by astronauts and fields experts will be described in detail.