Academic Corner
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In this issue, we are pleased to feature an interview with IEEE SMC member Prof. Giacinto Barresi (PhD in robotics, MSc in experimental psychology, BSc in cognitive psychobiology). He is a Professor at the Bristol Robotics Laboratory, UWE Bristol (United Kingdom), where he works on human-machine systems for health and safety. He is the chair for Telehealth and Telemedicine in the IEEE-Telepresence initiative, internationalisation co-representative in the Executive Committee of UK-RAS network, member of the Academic Committee of the IEEE RAS UK & Ireland Chapter, co-chair of the Technical Committee on Human Factors in Robotics at the International Ergonomics Association. He previously was a Researcher at Istituto Italiano di Tecnologia in Genoa (Italy), where he coordinated activities like the ENACT project, funded by the Italian Multiple Sclerosis Foundation. He also was a Scholar-In-Residence at the Indian Institute of Technology Gandhinagar (India), and a Guest Lecturer at the Kyushu University in Fukuoka (Japan).

(1) Please tell us a bit about yourself and your academic/professional background. How did your path from experimental psychology and cognitive neuroscience to robotics, cognition, and interaction technologies shape your human-centred approach to robotics?
I have always been problem-driven rather than tied to a discipline, an attitude inspired by Karl Popper. The first problem I desired to face has been the mind-body relationship, and the University of Padua (Italy) gave me rigorous methods (based on psychometrics, psychophysics, psychobiology) to study it. My passion for technology then led me to cognitive ergonomics, widening the problem into a mind-body-machine framework. In particular, working (teaching and applying techniques) as a specialist in user-centred design during my studies showed me how interactive devices can restore, assist, and augment human abilities. This vision guided my thirteen years at Istituto Italiano di Tecnologia (IIT), from my PhD in robotics at the University of Genoa (Italy) to my work in the Advanced Robotics Department and the Rehab Technologies Lab of the IIT (collaborating with partners like INAIL, the Italian institution for health and safety at work). There, my skills have grown, enabling me to lead research activities in biomedical robotics and digital health: co-coordinator of TEEP-SLA (project funded by Fondazione Roma and supported by Fondazione Sanità e Ricerca), principal investigator of ENACT (project funded by the Italian Multiple Sclerosis Foundation, FISM), and contributor to the RAISE innovation hub (funded by the Italian PNRR). Since July 2024 I continue this path as Professor in the School of Engineering of the University of the West of England (UWE Bristol, United Kingdom), and as a member of the Bristol Robotics Laboratory (BRL, joint initiative of UWE Bristol and the University of Bristol). This is a crucial step in my career, opening it to new challenges where fundamental research on bionic integration meets a tangible human-centric impact.

(2) Could you tell us about your current research at the Bristol Robotics Laboratory? What unifying ideas connect cognitive ergonomics, neuroergonomics, human-robot interaction, telerobotics, biofeedback, and healthcare robotics in your work?
At BRL, my work on human-robot interaction is moving towards shared control and shared autonomy, even targeting safety-critical fields like construction and aerospace. I focus on the "first-person" perspective of wearable, prosthetic, and teleoperative technologies. This perspective unifies my research on human-robot integration, including embodiment (feeling an external object as part of ourselves) and telepresence (feeling present with agents, objects, and events in a remote context). The aim is to enhance both human well-being and system performance, the goals of every ergonomist. Cognitive ergonomics studies the mental processes behind human-machine interactions; neuroergonomics brings neuroscientific methods into ecologically valid settings, similar to the actual

ones. Together they help me prioritise user needs in real contexts of health and safety, beyond the laboratory. Across these threads, biofeedback has been a leitmotiv for me: showing users their physiological signals so they can self-regulate them, improving both health (as in rehabilitation and prosthetic training) and control (as in training users of medical robots). It captures the principle unifying my work: closing the loop between human and technology.

(3) In your work on human-centred robotics for healthcare, what are the most important human factors that engineers tend to overlook when designing robotic systems for surgery, rehabilitation, prosthetics, or assistance? How should these considerations be incorporated from the beginning of the design process?

The risk is not so much overlooking human factors as believing they cannot be assessed objectively. To discuss this, in my lectures I illustrate how ISO standards define usability: effectiveness (we accomplish our task through a tool), efficiency (with minimal attention or time), and satisfaction (with comfort and gratification). Because questionnaires are routinely employed to evaluate usability, we may forget that effectiveness and efficiency can also be assessed objectively, through completion rates, execution time, and errors. Even satisfaction can be operationalised as persistence (time, again) in using a device, which is crucial when designing training protocols for users of biomedical robots (game-based features can powerfully engage them). Further factors deserve attention. One is technology acceptance: a device that is not accepted will be abandoned regardless of its mechatronic excellence, before practice can improve performance. This is why I study prosthetic embodiment, easing the integration of a device into the person's body schema. Another is trust, which must be calibrated: too little prevents acceptance, too much (automation bias) creates safety concerns. Co-design is the key: an iterative, participatory process with users and stakeholders from the very start of any project. This is why, at IIT, I developed a human-centred design framework for biomedical robotics based on the usability engineering process of IEC 62366.

(4) Neuroergonomics uses neural and physiological information to understand people interacting with technology. Which measures or methods do you find most promising for making robotic systems genuinely adaptive, while avoiding excessive complexity, cognitive burden, or intrusion for the user?

Measures should not be intrusive, or they alter the very information we need, especially in real contexts. Consumer wearables are promising (especially sensors for heart rate variability, skin conductance, even eye-tracking, and EEG) to estimate, for instance, mental workload without burdening users during daily activities. While we wait for improved low-cost devices (with better reliability in signal detection), we should focus on multimodal data analysis, anchored to performance indices that tell us how well the user is accomplishing (or not) a task. This lets us derive low-cost digital and mechatronic biomarkers for precision medicine from the devices people already use (including smartphones). It matters most when we move from monitoring to adaptation and personalisation: aligning human and machine needs both technical and experiential progress, so that the technology can interpret the user's intentions and conditions, then follow the first and improve the second.

(5) Teleoperation and shared autonomy are increasingly important in telehealth, telemedicine, and other remote robotic applications. How should control authority be divided between the human and the robot when latency, uncertainty, workload, or safety become critical?

Control authority should be negotiated continuously, driven by the human factors (above I mentioned mental workload, technology acceptance, and trust). Humans keep authority over goals and intentions, while the robot takes over execution when latency, uncertainty, or fatigue would make direct control ineffective or inefficient. I learned this during my PhD, in the μRALP project, where haptic active constraints let surgeons feel the boundaries of a safe workspace: the surgeon stayed in charge, but the system prevented errors due, for instance, to fatigue after hours of activity. Another lesson came fron people with Motor Neuron Disease in TEEP-SLA: if control options are very narrow for the user, the robot must assist without removing agency, in that case by reading spontaneous physiological reactions of the users to adjust its actions without explicit commands. In diverse contexts (from industrial manufacturing to drone piloting), neuroergonomic adaptation can make authority shift to the machine when the operator is saturated and back when they become available again or when complexities exceed the capabilities of the machine itself. Two conditions keep this safe: transparency, so humans always know who is in control, and calibrated trust, so automation never becomes overreliance. These are topics I wish to bring to the IEEE Telepresence Initiative, as application chair for telehealth and telemedicine, and to IEEE Telepresence 2026, the conference we will soon host in Bristol.

(6) You have also explored embodiment and brain-robot interfaces. How can a stronger sense of embodiment and presence improve prosthetics, rehabilitation, or telepresence, and what are the main scientific barriers to translating these concepts into everyday use?

Embodiment and presence are experiential aspects of human-machine integration. A prosthesis felt as part of the body, or an avatar that makes us present elsewhere (virtually, or, in the case of telepresence, physically), can be used more spontaneously, more persistently, and with less effort. This is why I work on spatial augmented reality settings where respiratory and cardiac biofeedback enhances the embodiment of an artificial limb. On telepresence, a milestone of my career adds evidence. At the end of TEEP-SLA, a person with Amyotrophic Lateral Sclerosis visited the Vatican Museums (including the Sistine Chapel) through a telepresence system we designed. Beyond technology, what mattered was the feeling of being there, sharing an experience with other people. The translational barriers for these concepts, in my opinion, are due to the investigation methodologies. Embodiment and presence are still assessed mostly through questionnaires, so we need objective correlates that work outside the laboratory (also considering how individual variability is high, especially in clinical populations). Furthermore, the human-robot integration experience induced in a session must become stable across daily use, which also calls for neuroergonomic data from real contexts.

(7) Looking ahead over the next 5-10 years, which developments in AI, immersive technologies, digital twins, neurotechnology, or robotics do you think will most reshape human-machine systems? What underexplored opportunities are you most excited about?

I expect the deepest change from a convergence, not a single technology. Smartphones and consumer wearables (low-cost neurotechnologies, in some cases) are becoming impactful sensors for peripheral neuroergonomics. Combined with performance data, even smartphones can offer mobile biomarkers of health and workload in daily life (a perspective I am discussing with the Open University). AI models can then interpret such multimodal data, making neuroadaptive systems feasible at scale. Together, these trends can turn immersive environments and digital twins into tools that continuously personalise rehabilitation, prosthetic training, or teleoperation. I am currently exploring these options in physical-digital (phygital) scenarios for improving human-robot systems: the malleability of virtual and augmented environments and the richness of non-invasive stimulations (haptic feedback above all) can facilitate interaction between a person and a mechatronic device by adapting the digital layer to the user's state and the task at hand. In my opinion, underexplored opportunities are in contexts rather than technologies. One is occupational well-being and safety, as robots enter workplaces like construction sites, where bionic integration becomes a matter of protection and augmentation. This is a challenge requiring the involvement of all stakeholders (e.g., trade unions) to design ethical and sustainable solutions. Another one is education, a domain I care deeply about, from STEM teaching with a focus on accessibility (as in the GameAbility initiative I led in Italy) to events like the recent UWE Telerobotics Summer School, supported by the IEEE Telepresence Initiative and the IEEE RAS Technical Committee on Telerobotics.

(8) What role have IEEE and the IEEE Systems, Man, and Cybernetics Society played in your career so far? Looking ahead, what should the SMC community prioritize, and what advice would you give to early-career researchers working across robotics, cybernetics, human factors, and healthcare?

IEEE is the ecosystem in which I grew as a researcher, and the SMC Society has always been a natural home for me: its focus on human-machine systems embraces the mind-body-machine processes driving my curiosity. My work on brain-controlled augmented feedback for surgical training was presented at SMC 2015, and other editions of the same conference hosted my later studies on biofeedback exergames and prosthetic embodiment. It also gave me the chance to serve the academic community, as chair of workshops at SMC 2022, 2023, and 2025, and as associate editor of IEEE Transactions on Human-Machine Systems. It connected me with IEEE-RAS, IEEE-EMBS, and the Telepresence initiative. What I most appreciate in SMC is its perspective on systems rather than specific technologies: this is inherently connected to the very core of ergonomics, and it expands my view toward cybernetics and bionics, with all the tools they offer to address mind-body-machine interaction problems.

Looking ahead, I would gladly contribute to SMC through the exploration of human-machine integration (including human-robot integration) as a unifying framework with the potential to help and enhance our abilities. I would enjoy discussing with the SMC community the first-person perspective shared by wearable, prosthetic, and telerobotic technologies, and how we can reuse solutions across permanent, situational, and temporary impairments so that assistive and rehabilitative tools also serve augmentation, and vice versa.

My advice to early-career researchers: be problem-driven rather than discipline-driven, learn the methods of your neighbours, and spend time with the people who will use your solutions.