

Institutional Projects

STEREOS + 2009-2010

Images review station for orthopaedics - MEDICEN

Partners: Biospace med, Société Global Imaging, MAS Ecole Centrale, CHU Robert Debré, CHU Lariboisière, CHU Pitié Salpêtrière, Centre d'Imagerie Alfred Bruneau.

SECUR_ENFANT 2006-2009

Child transportation safety: improvement of numerical models bio-fidelity - ANR

Partners: LBA Univ. Méditerranée-INRETS UMRT 24, LBMC Univ. Lyon- INRETS UMRT 9406.

MIRAS 2009-2013

Multimodal interactive strolling assistance robot - ANR

Partners: Société ROBOSOFT, ISIR Univ. Pierre et Marie Curie-CNRS FRE 2507, LAAS-CNRS, Société MEDIALIS, Gérontechnologie La Grave CHU Toulouse, Hôpital Charles Foix.

SACR_FRM 2006-2010

Approaches of biomechanics, distributed artificial intelligence and sociology for the development of a help system in the choice and settings of wheelchairs - ANR

Partners: LAMIH Univ. Valenciennes-CNRS UMR 8530, Sociétés TRS, DUPONT Médical et OTTOBOCK, CIT Hôpital Raymond Poincaré, SMPR CHRU de Lille, LBMC Univ. Lyon - INRETS UMRT 9406, LIMOS Univ. Clermont Ferrand-CNRS UMR 6158, CERMES EHESS-CNRS UMR 8169 INSERM U750.

I.L.I. 2009-2013

Implants - Software - Imaging: alternative for the treatment of vertebral fractures - OSEO ISI

Partners: Biospace med, Société VEXIM.

HIPEOS 2009-2012

3D functional imaging of hip joint for diagnosis, planification and surgical follow-up of children and adults - ANR

Partners: Société Biospace med, LATIM-INSERM U650, Hôpital de la Timone, Hôpital Pitié Salpêtrière.

BONUS 2007-2010

Assessment of bone biomechanical health using nonlinear acoustic techniques - ANR

Partners: LIP Univ. Paris 6-CNRS UMR 7623, LUSSE Univ. Tours-CNRS FRE 2448.

LIGART 2007-2010

Synthetic « bioactive » and « biointegrable » ligament allowing fast rehabilitation of the patient: chemical graft, *in vivo* biological evaluations, animal experiments, pre-clinical studies - ANR

Partners: Inst. Gallée Univ. Paris 13-CNRS UMR 7052, LRO Univ. Paris 7-CNRS UMR 7052, Ecole Nationale Vét. d'Alfort, Société LARS.

MODOS 2009-2012

Multi-scale modelling of the femoral upper extremity integrating cellular activities: patient-specific prediction of the osteoporotic fracture risk - ANR

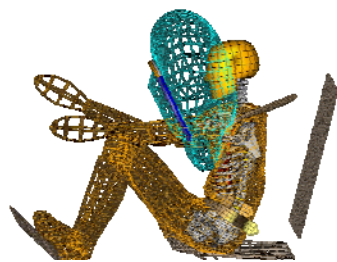
Partners: Institut PRISME, INSERM U658 CHR Orléans, LRE Univ. Paris 7-CNRS UMR 7052, Société CADLM.

European Project

VPHOP 2008-2012

The Osteoporotic Virtual Physiological Human

Partners: Istituti Ortopedici Rizzoli (IT), Technische Universiteit Eindhoven (NL), EMP (DE), SCS srl (IT), Charité Berlin (DE), Eidgenössische Technische Hochschule (CH), Univ. Geneva (CH), Univ. Bern (CH), Sylvia Center (DE), Société ANSYS (FR), Kath. Univ. Leuven (BE), Univ. Bedfordshire (UK), Univ. Iceland (IS), Univ. Uppsala (SE), INSERM (FR), Société Biospace med (FR), BrainLAB AG (DE), Société Philips Medical System (NL).



Collaboration LAB PSA Renault INRETS

Equipment

- A functional exploration platform with the EOS system, gait analysis Vicon system, and several posture and functional exploration devices.

- An experimental *in vitro* static and dynamic testing area including test machines and specific systems designed in LBM, for structures and tissues characterization. Implant evaluation is performed by comparing intact, injured or instrumented configurations. These experiments are conducted within a convention with the Body Donation Center, René Descartes University, Paris V.

- A leading-edge software development system (more than 100 computers and dedicated software for numerical analysis, finite element modelling and surgery simulation).



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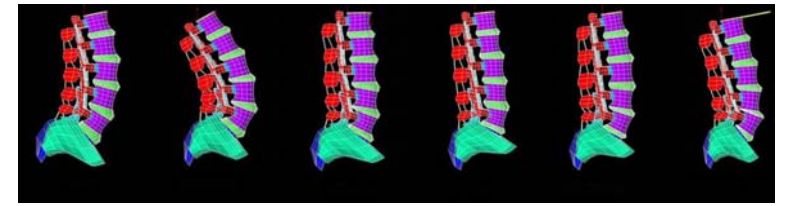
Web: <http://bio-web.paris.ensam.fr/>



The Laboratory of Biomechanics Arts et Métiers ParisTech CNRS (LBM) was created in 1979. It has a staff of more than 50 persons including engineers and clinicians, organized in 3 research teams. LBM is focused on musculoskeletal biomechanics, with a wide range of approaches for subject-specific modelling, together with *in vitro* analysis and *in vivo* functional evaluation.



Using numerical models, validated through *in vitro* experiments. Geometrical data derive from medical images (XRays, CT-scan, MRI, 3D-DXA, EOS)

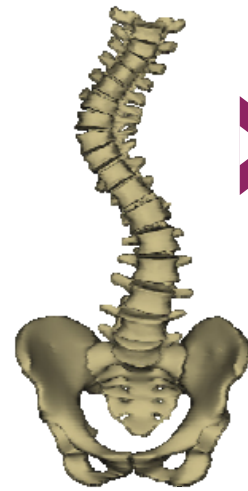


Better Understand to Better Innovate, to Serve Patients and Society

Health technology is a priority research area at national level. Research in biomechanics represents a significant challenge linked to strong growth markets, major public health concerns and prevention of road injuries. In transportation, medical and sport industries, biomechanical modelling of the human being is an essential basis for innovation.

Research in biomechanics uses structural mechanics approaches for geometric and mechanical modelling, and for experimental analysis. However, several scientific barriers still exist, in terms of patient-specific geometry, constitutive equations of biological materials depending on growth and aging, and intra-articular loads. *In vivo* models validation in real-life situation for patients with musculoskeletal disorders is also a key issue. Facing these challenges requires development of innovative methods for quantitative exploration that go far beyond the field of mechanics and anatomy, with specific clinical and ethical constraints.

In this context, multidisciplinary is essential: mechanical engineers, orthopaedists, image processing experts, physiologists, radiologists, motor control and physics researchers, meet in a common scientific space to better understand musculoskeletal behaviour, disorders, mechanisms of injury, repair and rehabilitation. They contribute to innovation for devices and implants design, or computer-based diagnosis and evaluation tools.



Analysis of biomechanical issues related to osteoporosis, arthrosis, scoliosis or other joint diseases

EOS, a major innovation

Joint expertise of engineers, physics researchers and clinicians of various specialties has led to the design of EOS, a 3D low-dose biplanar radiographic system which is the result of a partnership between LBM, Saint Vincent de Paul Hospital, Laboratoire de Recherche en Imagerie et Orthopédie (LIO), Montreal, Professor G. Charpak (1992 Physics Nobel Prize) and Biospace Med company. Easy to use, EOS system allows to capture the patient X-Rays in a standing load-bearing position, resulting in a totally new vision of the postural troubles and their associated compensation mechanisms. Two Biomedical Research Protocols, approved by the BioEthics Committee (CPP), are implemented in LBM for adults and children.



EOS system is the result of a close collaboration between clinical, academic and industrial partners



Bringing together clinicians and engineers in a common scientific hub to better understand and better innovate

Research Teams

Musculoskeletal Modelling and Clinical Innovation

Oriented towards patient-specific biomechanical modelling of the musculoskeletal system, this research aims to improve the understanding of pathologies resulting from degenerative processes, traumatism or handicap, as well as to develop computer aided diagnosis and therapeutic tools, or design implants and technical aids.

Biomechanics: Sport, Health and Safety

This research, carried out in clinical site (CHU Avicenne-University Paris 13), copes with three issues: inter-relationships between sportive practice and musculoskeletal remodelling in order to optimize the performance while reducing induced pathology; mechanisms of injury after impacts (road crash, sports) to improve protection devices; tissues and structures characterization at various loading speeds.

Biomechanics and Nervous System: Motion analysis and Restoration

This research is based in clinical site (CHU Henri Mondor Créteil). The aim is to better understand relationships existing between motion muscular actuators and their neurocontrol command. Analyzing and modelling motion disorders that happen subsequently to a neurological handicap, leads to design and objective evaluation of rehabilitation protocols.

Education, Industry and Quality

Valorisation and Industrial Relationship

Since 2002, LBM has structured an internal specific entity, the Valorisation and Industrial Relationship group. Its objectives are to reinforce industrial partnerships and accelerate technology transfer. Applied research is based on tools and methods developed in LBM. *In vitro* experiments performed on spine, knee and scapula are COFRAC (ISO 17025) accredited.

ISO 9001 Certification

Willing to develop the best methods, to structure its work in optimal conditions and to continuously improve its internal organization, LBM obtained ISO 9001 certification on 29th July 2009, in an area covering Research, Education, Industrial Partnerships and Valorisation.



To develop innovations for the design and evaluation of implants and technical aids, in the fields of health, sport and transportation

Education through Research

BIOST Mention (Osteo-articular and Tissues Biomechanics) is a Master of Science and Technology of Arts et Metiers ParisTech, conducted in partnership with professors and researchers of Paris 5, 6, 7, 12 et 13 Medical Universities. This program moves as a track into the BME ParisTech – Paris Descartes Master in Biomedical Engineering.

This education program is oriented towards both engineering students and medical practitioners (orthopaedic surgeons, neuro-surgeons, etc.).

Professors and researchers of LBM also supervise PhD students in the field of Biomechanics and Bio-engineering.

