Horizon 2020

Call: H2020-WIDESPREAD-2016-2017
(WIDESPREAD)

Topic: WIDESPREAD-05-2017

Type of action: CSA
(Coordination and support action)

Proposal number: 810043

Proposal acronym: BATEAU

Deadline Id: H2020-WIDESPREAD-05-2017-Twinning
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How to fill in the forms

The administrative forms must be filled in for each proposal using the templates available in the submission system. Some data fields in the administrative forms are pre-filled based on the previous steps in the submission wizard.

Proposal ID **810043** *Acronym* **BATEAU**

1 - General information

Topic	WIDESPREAD-05-2017
Call Identifier	H2020-WIDESPREAD-2016-2017
Type of Action	CSA
Deadline Id	H2020-WIDESPREAD-05-2017-Twinning

Acronym	BATEAU
Proposal title	Excellence transfer to PUT in the solid body evolution and growth modeling research area based on the idea of concepts flow from biological and medical sciences to engineering and vice versa

Note that for technical reasons, the following characters are not accepted in the Proposal Title and will be removed: < > " &

Duration in months	*36*

Please select between 3 and 6 descriptors that best characterise the subject of your proposal, in descending order of relevance. Note that descriptors will be used to support REA services in identifying the best qualified evaluators for your proposal.

Descriptor 1	**Discipline:** Mechanical engineering **Subdiscipline:** Mechanical engineering **Descriptor:** Product Development
Descriptor 2	**Discipline:** Biological sciences **Subdiscipline:** Cell biology, Microbiology **Descriptor:** Tissue culture
Descriptor 3	**Discipline:** Computer sciences, information science and bioinformatics **Subdiscipline:** Artificial intelligence, intelligent systems, multi agent systems **Descriptor:** Scientific computing, simulation and modelling tools
Free keywords	*tissues, materials, optimization, structural optimization, evolutionary solid bodies, biological processes modeling, material design, biomedical application*

Proposal ID **810043** *Acronym* **BATEAU**

Abstract

The area of a solid body evolution and growth modeling focused recently a noticeable attention of scientists representing various research fields and notes a rapid progress. The staff of the Poznań University of Technology (PUT), in particular of the Faculties taking part in the project, has so far gained quite an experience in the research within the area of the solid body evolution and growth modeling. However, the potential of the university in the field is not yet fully utilized, for the university faces some capacities gaps and the BATEAU project will change this situation.
An enhancement of the research capabilities of PUT within the area of the solid body evolution and growth modeling and their applications is to be accomplished by establishing a cooperative network linking, besides PUT, also three other European research centers, namely: Université de Lorraine from France, The M&MoCS International Research Center from Italy, and Dortmund Technical University from Germany. There are several activities planned within BATEAU (such as staff and students exchange, thematic workshops, summer schools, study sessions) each of which is aimed at enabling and boosting an excellence transfer to PUT concerning concepts flow from biological and medical sciences to engineering and vice versa in the area of interest. The advantages of the project are to be beneficial not only for the employees of PUT, for an extensive concern is also devoted to allow the Ph.D. and advanced M.Sc. students from the university to make use of the knowledge, expertise, and experience which the foreign partners bring to BATEAU. Furthermore, besides scientific and educational aspects, an important role in the project is also played by objectives focusing on an enhancement of nontechnical
capacities of the staff of PUT. Additionally, a special attention is devoted to the dissemination of the projects outcomes. The project is perfectly in line with the TWINNING objectives.

Remaining characters 27

Has this proposal (or a very similar one) been submitted in the past 2 years in response to a call for proposals under Horizon 2020 or any other EU programme(s)? ○ Yes ◉ No

Proposal ID **810043** *Acronym* **BATEAU**

Declarations

1) The coordinator declares to have the explicit consent of all applicants on their participation and on the content of this proposal.	☒
2) The information contained in this proposal is correct and complete.	☒
3) This proposal complies with ethical principles (including the highest standards of research integrity — as set out, for instance, in the European Code of Conduct for Research Integrity — and including, in particular, avoiding fabrication, falsification, plagiarism or other research misconduct).	☒

4) The coordinator confirms:

- to have carried out the self-check of the financial capacity of the organisation on http://ec.europa.eu/research/participants/portal/desktop/en/organisations/lfv.html or to be covered by a financial viability check in an EU project for the last closed financial year. Where the result was "weak" or "insufficient", the coordinator confirms being aware of the measures that may be imposed in accordance with the H2020 Grants Manual (Chapter on Financial capacity check); or	◉
- is exempt from the financial capacity check being a public body including international organisations, higher or secondary education establishment or a legal entity, whose viability is guaranteed by a Member State or associated country, as defined in the H2020 Grants Manual (Chapter on Financial capacity check); or	○
- as sole participant in the proposal is exempt from the financial capacity check.	○

5) The coordinator hereby declares that each applicant has confirmed:

- they are fully eligible in accordance with the criteria set out in the specific call for proposals; and	☒
- they have the financial and operational capacity to carry out the proposed action.	☒

The coordinator is only responsible for the correctness of the information relating to his/her own organisation. Each applicant remains responsible for the correctness of the information related to him/her and declared above. Where the proposal to be retained for EU funding, the coordinator and each beneficiary applicant will be required to present a formal declaration in this respect.

According to Article 131 of the Financial Regulation of 25 October 2012 on the financial rules applicable to the general budget of the Union (Official Journal L 298 of 26.10.2012, p. 1) and Article 145 of its Rules of Application (Official Journal L 362, 31.12.2012, p.1) applicants found guilty of misrepresentation may be subject to administrative and financial penalties under certain conditions.

Personal data protection
The assessment of your grant application will involve the collection and processing of personal data (such as your name, address and CV), which will be performed pursuant to Regulation (EC) No 45/2001 on the protection of individuals with regard to the processing of personal data by the Community institutions and bodies and on the free movement of such data. Unless indicated otherwise, your replies to the questions in this form and any personal data requested are required to assess your grant application in accordance with the specifications of the call for proposals and will be processed solely for that purpose. Details concerning the purposes and means of the processing of your personal data as well as information on how to exercise your rights are available in the privacy statement. Applicants may lodge a complaint about the processing of their personal data with the European Data Protection Supervisor at any time.

Your personal data may be registered in the Early Detection and Exclusion system of the European Commission (EDES), the new system established by the Commission to reinforce the protection of the Union's financial interests and to ensure sound financial management, in accordance with the provisions of articles 105a and 108 of the revised EU Financial Regulation (FR) (Regulation (EU, EURATOM) 2015/1929 of the European Parliament and of the Council of 28 October 2015 amending Regulation (EU, EURATOM) No 966/2012) and articles 143 - 144 of the corresponding Rules of Application (RAP) (COMMISSION DELEGATED REGULATION (EU) 2015/2462 of 30 October 2015 amending Delegated Regulation (EU) No 1268/2012) for more information see the Privacy statement for the EDES Database).

Proposal ID **810043** *Acronym* **BATEAU**

List of participants

#	Participant Legal Name	Country
1	POLITECHNIKA POZNANSKA	Poland
2	UNIVERSITE DE LORRAINE	France
3	UNIVERSITA DEGLI STUDI DELL'AQUILA	Italy
4	TECHNISCHE UNIVERSITAT DORTMUND	Germany

Proposal ID **810043** *Acronym* **BATEAU** *Short name* **POLITECHNIKA POZNANSKA**

2 - Administrative data of participating organisations

PIC	***Legal name***
999659691	*POLITECHNIKA POZNANSKA*

Short name: POLITECHNIKA POZNANSKA

Address of the organisation

Street PL MARII SKLODOWSKIEJ CURIE 5

Town POZNAN

Postcode 60 965

Country Poland

Webpage www.put.poznan.pl

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... yes
Non-profit ..... yes
International organisation ..... no
International organisation of European interest ..... no
Secondary or Higher education establishment ..... yes
Research organisation ..... yes

Legal person ..... yes

Enterprise Data

SME self-declared status ..... 31/12/2014 - no
SME self-assessment ..... 31/12/2014 - no
SME validation sme ..... 06/03/2009 - no

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal ID **810043** *Acronym* **BATEAU** *Short name* **POLITECHNIKA POZNANSKA**

Department(s) carrying out the proposed work

Department 1

Department name: Faculty of Machines and Transport ☐ not applicable

☒ Same as organisation address

Street: PL MARII SKLODOWSKIEJ CURIE 5

Town: POZNAN

Postcode: 60 965

Country: Poland

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **810043** *Acronym* **BATEAU** *Short name* **POLITECHNIKA POZNANSKA**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Prof. Sex: (•) Male ( ) Female

First name: **Michal** Last name: **Nowak**

E-Mail: **michal.nowak@put.poznan.pl**

Position in org.: Profesor

Department: Chair of Virtual Engineering ☐ Same as organisation

☐ Same as organisation address

Street: Jana Pawla II 24 / 414

Town: Poznan Post code: 61139

Country: Poland

Website: http://virtual.edu.pl/

Phone 1: +48616653113 Phone 2: +48608525761 Fax: +xxx xxxxxxxxx

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Anna	Koralewska	anna.koralewska@put.poznan.pl	+48616653618
Kamil	SEDLAK	kamil.sedlak@gmail.com	+48608525761

Proposal ID **810043** *Acronym* **BATEAU** *Short name* **UL**

PIC	***Legal name***
954831626	*UNIVERSITE DE LORRAINE*

Short name: UL

Address of the organisation

Street COURS LEOPOLD 34

Town NANCY CEDEX

Postcode 54052

Country France

Webpage www.univ-lorraine.fr

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... yes

Non-profit ..... yes

International organisation ..... no

International organisation of European interest ..... no

Secondary or Higher education establishment ..... yes

Research organisation ..... yes

Legal person ..... yes

Enterprise Data

SME self-declared status..... 22/09/2011 - no

SME self-assessment ..... unknown

SME validation sme ..... 22/09/2011 - no

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal ID **810043** *Acronym* **BATEAU** *Short name* **UL**

Department(s) carrying out the proposed work

Department 1

Department name: LEMTA ☐ not applicable

☐ Same as organisation address

Street: 2, Avenue de la Forêt de Haye TSA 60604

Town: Vandoeuvre les Nancy Cedex

Postcode: 54518

Country: France

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **810043** *Acronym* **BATEAU** *Short name* **UL**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Prof. Sex: (•) Male ( ) Female

First name: **Jean-François** Last name: **Ganghoffer**

E-Mail: **jean-francois.ganghoffer@univ-lorraine.fr**

Position in org.: profesor

Department: LEMTA ☐ Same as organisation

☐ Same as organisation address

Street: 2, Avenue de la Forêt de Haye TSA 60604

Town: Vandoeuvre les Nancy Cedex Post code: 54518

Country: France

Website: www.lemta.fr

Phone 1: +33383595724 Phone 2: +33688268240 Fax: +33383595551

Proposal ID **810043** *Acronym* **BATEAU** *Short name* **UNIVAQ**

PIC	***Legal name***
999859511	*UNIVERSITA DEGLI STUDI DELL'AQUILA*

Short name: UNIVAQ

Address of the organisation

Street PIAZZA VINCENZO RIVERA 1

Town L AQUILA

Postcode 67100

Country Italy

Webpage

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... yes

Non-profit ..... yes

International organisation ..... no

International organisation of European interest ..... no

Secondary or Higher education establishment ..... yes

Research organisation ..... yes

Legal person ..... yes

Enterprise Data

SME self-declared status..... 07/03/2014 - no

SME self-assessment ..... 07/03/2014 - no

SME validation sme ..... unknown

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal ID **810043** *Acronym* **BATEAU** *Short name* **UNIVAQ**

Department(s) carrying out the proposed work

Department 1

Department name: MEMOCS ☐ not applicable

☐ Same as organisation address

Street: Zona Industriale di Bazzano, Località Mo

Town: L'Aquila

Postcode: 67040

Country: Italy

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **810043** *Acronym* **BATEAU** *Short name* **UNIVAQ**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Prof. | Sex: (•) Male ( ) Female

First name: **Francesco** | Last name: **dell'Isola**

E-Mail: **fdellisola@icloud.com**

Position in org.: profesor

Department: MEMOCS ☐ Same as organisation

☐ Same as organisation address

Street: Zona Industriale di Bazzano, Località Monticchio

Town: L'Aquila | Post code: 67040

Country: Italy

Website: http://memocs.univaq.it

Phone 1: +390662434503 | Phone 2: +xxx xxxxxxxxx | Fax: +390862434548

Proposal ID **810043** *Acronym* **BATEAU** *Short name* **TUDO**

PIC	***Legal name***
999848453	*TECHNISCHE UNIVERSITAT DORTMUND*

Short name: TUDO

Address of the organisation

Street AUGUST SCHMIDT STRASSE 4

Town DORTMUND

Postcode 44227

Country Germany

Webpage www.tu-dortmund.de

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... yes

Non-profit ..... yes

International organisation ..... no

International organisation of European interest ..... no

Secondary or Higher education establishment ..... yes

Research organisation ..... yes

Legal person ..... yes

Enterprise Data

SME self-declared status..... 27/10/2008 - no

SME self-assessment ..... unknown

SME validation sme ..... 27/10/2008 - no

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Proposal ID **810043** *Acronym* **BATEAU** *Short name* **TUDO**

Department(s) carrying out the proposed work

Department 1

Department name: Institute of Mechanics ☐ not applicable

☐ Same as organisation address

Street: Leonhard-Euler-Strasse 5

Town: Dortmund

Postcode: 44227

Country: Germany

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **810043** *Acronym* **BATEAU** *Short name* **TUDO**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Prof. Sex: (•) Male ( ) Female

First name: **Andreas** Last name: **Menzel**

E-Mail: **andreas.menzel@udo.edu**

Position in org.: Professor

Department: Mechanical Engineering ☐ Same as organisation

☐ Same as organisation address

Street: Mechanical Engineering

Town: Dortmund Post code: 44227

Country: Germany

Website: www.iofm.de

Phone 1: +492317557978 Phone 2: +492317555744 Fax: +492317552688

Proposal ID **810043** *Acronym* **BATEAU**

3 - Budget for the proposal

No	Participant	Country	(A) Direct personnel costs/€	(B) Other direct costs/€	(C) Direct costs of sub-contracting/€	(D) Direct costs of providing financial support to third parties/€	(E) Costs of inkind contributions not used on the beneficiary's premises/€	(F) Indirect Costs / € (=0.25(A+B-E))	(G) Special unit costs covering direct & indirect costs / €	(H) Total estimated eligible costs / € (=A+B+C+D+F+G)	(I) Reimburse-ment rate (%)	(J) Max.EU Contribution / € (=H*I)	(K) Requested EU Contribution/ €
1	Politechnika Poznanska	PL	99875	230601	0	0	0	82619,00	0	413095,00	100	413095,00	413095,00
2	UI	FR	100100	55400	0	0	0	38875,00	0	194375,00	100	194375,00	194375,00
3	Univaq	IT	105610	70402	0	0	0	44003,00	0	220015,00	100	220015,00	220015,00
4	Tudo	DE	80400	55400	0	0	0	33950,00	0	169750,00	100	169750,00	169750,00
	Total		385985	411803	0	0	0	199447,00	0	997235,00		997235,00	997235,00

Proposal ID **810043** *Acronym* **BATEAU**

4 - Ethics issues table

1. HUMAN EMBRYOS/FOETUSES		Page
Does your research involve Human Embryonic Stem Cells (hESCs)?	○ Yes ◉ No	
Does your research involve the use of human embryos?	○ Yes ◉ No	
Does your research involve the use of human foetal tissues / cells?	○ Yes ◉ No	
2. HUMANS		**Page**
Does your research involve human participants?	○ Yes ◉ No	
Does your research involve physical interventions on the study participants?	○ Yes ◉ No	
3. HUMAN CELLS / TISSUES		**Page**
Does your research involve human cells or tissues (other than from Human Embryos/ Foetuses, i.e. section 1)?	○ Yes ◉ No	
4. PERSONAL DATA		**Page**
Does your research involve personal data collection and/or processing?	○ Yes ◉ No	
Does your research involve further processing of previously collected personal data (secondary use)?	○ Yes ◉ No	
5. ANIMALS		**Page**
Does your research involve animals?	○ Yes ◉ No	
6. THIRD COUNTRIES		**Page**
In case non-EU countries are involved, do the research related activities undertaken in these countries raise potential ethics issues?	○ Yes ◉ No	
Do you plan to use local resources (e.g. animal and/or human tissue samples, genetic material, live animals, human remains, materials of historical value, endangered fauna or flora samples, etc.)?	○ Yes ◉ No	
Do you plan to import any material - including personal data - from non-EU countries into the EU?	○ Yes ◉ No	
Do you plan to export any material - including personal data - from the EU to non-EU countries?	○ Yes ◉ No	
In case your research involves low and/or lower middle income countries, are any benefits-sharing actions planned?	○ Yes ◉ No	
Could the situation in the country put the individuals taking part in the research at risk?	○ Yes ◉ No	

Proposal ID **810043** *Acronym* **BATEAU**

7. ENVIRONMENT & HEALTH and SAFETY		Page
Does your research involve the use of elements that may cause harm to the environment, to animals or plants?	○ Yes ◉ No	
Does your research deal with endangered fauna and/or flora and/or protected areas?	○ Yes ◉ No	
Does your research involve the use of elements that may cause harm to humans, including research staff?	○ Yes ◉ No	
8. DUAL USE		**Page**
Does your research involve dual-use items in the sense of Regulation 428/2009, or other items for which an authorisation is required?	○ Yes ◉ No	
9. EXCLUSIVE FOCUS ON CIVIL APPLICATIONS		**Page**
Could your research raise concerns regarding the exclusive focus on civil applications?	○ Yes ◉ No	
10. MISUSE		**Page**
Does your research have the potential for misuse of research results?	○ Yes ◉ No	
11. OTHER ETHICS ISSUES		**Page**
Are there any other ethics issues that should be taken into consideration? Please specify	○ Yes ◉ No	

I confirm that I have taken into account all ethics issues described above and that, if any ethics issues apply, I will complete the ethics self-assessment and attach the required documents. ☒

How to Complete your Ethics Self-Assessment

Proposal ID **810043** *Acronym* **BATEAU**

5 - Call specific questions

Extended Open Research Data Pilot in Horizon 2020

If selected, applicants will by default participate in the Pilot on Open Research Data in Horizon 2020[1] , which aims to improve and maximise access to and re-use of research data generated by actions.

However, participation in the Pilot is flexible in the sense that it does not mean that all research data needs to be open. After the action has started, participants will formulate a Data Management Plan (DMP), which should address the relevant aspects of making data FAIR – findable, accessible, interoperable and re-usable, including what data the project will generate, whether and how it will be made accessible for verification and re-use, and how it will be curated and preserved. Through this DMP projects can define certain datasets to remain closed according to the principle "as open as possible, as closed as necessary". A Data Management Plan does not have to be submitted at the proposal stage.

Furthermore, applicants also have the possibility to opt out of this Pilot completely at any stage (before or after the grant signature). In this case, applicants must indicate a reason for this choice (see options below).

Please note that participation in this Pilot does not constitute part of the evaluation process. Proposals will not be penalised for opting out.

We wish to opt out of the Pilot on Open Research Data in Horizon 2020.	○ Yes	◉ No

Further guidance on open access and research data management is available on the participant portal: http://ec.europa.eu/research/participants/docs/h2020-funding-guide/cross-cutting-issues/open-access-dissemination_en.htm and in general annex L of the Work Programme.

[1] *According to article 43.2 of Regulation (EU) No 1290/2013 of the European Parliament and of the Council, of 11 December 2013, laying down the rules for participation and dissemination in "Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020)" and repealing Regulation (EC) No 1906/2006.*

BATEAU

Excellence transfer to PUT in the solid body evolution and growth modeling research area based on the idea of concepts flow from biological and medical sciences to engineering and vice versa

Participant No	Participant organisation name	Participant short name	Country	Org. Type
1 (Coordinator)	Poznan University of Technology	PUT	Poland	University
2	Université de Lorraine - ESPE	UL	France	University
3	The International Research Center for Mathematics & Mechanics of Complex Systems (M&MoCS)	M&MoCS	Italy	University
4	TU Dortmund University	TUDO	Germany	University

Technical Annex Sections 1-3

Table of Contents

Project abstract:

The area of a solid body evolution and growth modeling focused recently a noticeable attention of scientists representing various research fields and notes a rapid progress. The staff of the Poznań University of Technology (PUT), in particular of the Faculties taking part in the project, has so far gained quite an experience in the research within the area of the solid body evolution and growth modeling. However, the potential of the university in the field is not yet fully utilized, for the university faces some capacities gaps and the BATEAU project will change this situation.

An enhancement of the research capabilities of PUT within the area of the solid body evolution and growth modeling and their applications is to be accomplished by establishing a cooperative network linking, besides PUT, also three other European research centers, namely: Université de Lorraine from France, The M&MoCS International Research Center from Italy, and Dortmund Technical University from Germany. There are several activities planned within BATEAU (such as staff and students exchange, thematic workshops, summer schools, study sessions) each of which is aimed at enabling and boosting an excellence transfer to PUT concerning concepts flow from biological and medical sciences to engineering and vice versa in the area of interest. The advantages of the project are to be beneficial not only for the employees of PUT, for an extensive concern is also devoted to allow the Ph.D. and advanced M.Sc. students from the university to make use of the knowledge, expertise, and experience which the foreign partners bring to BATEAU. Furthermore, besides scientific and educational aspects, an important role in the project is also played by objectives focusing on an enhancement of non-technical capacities of the staff of PUT. Additionally, a special attention is devoted to the dissemination of the projects outcomes. The project is perfectly in line with the TWINNING objectives.

1. Excellence

1.1 Objectives

Poznan University of Technology has an immense potential in the research area of solid body evolution and growth modeling. PUT Chair of Virtual Engineering developed the structural optimization system that allows the simultaneous optimization of size, shape and topology useful in industrial applications. Research in the new area joining the technical and biological/medical aspects has been developing in PUT for many years, the focus being on using the concepts flow from biological and medical sciences to engineering and vice versa.

But PUT also has some capacities gaps in the research area covered by the project, which makes its ambitious plans (e.g. of establishing a new Biomechanics faculty) may take a long time to be accomplished. Therefore, the opportunities opened by the Twinning programme were received by PUT with enthusiasm, as they are very much in line with the current needs of PUT. PUT will greatly benefit from external support to fill its capacities gaps and to be able to further develop the solid body evolution and growth modeling area.

There has been a previous cooperation between PUT and UL in this research area and this is why the idea came out to continue and intensify this cooperation within the Twinning programme. The specific research topics have been defined in which PUT would need support. And then it has been decided that M&MoCS and TUDO (next to UL) would be the perfect consortium partners, as the internationally-leading institutions in the topics of interest for PUT. UL, M&MoCS and TUDO have been closely cooperating for years and they are open to welcome in their group the Poznan University of Technology. It is understood by all the consortium members that even if the aim of the BATEAU project is to transfer excellence from the Western research centers (UL, M&MoCS and TUDO) to Poznan, this project will also have beneficial effects for the other consortium members. It is understood that the research area of solid body evolution and growth modeling will be more developed and that it will stimulate innovation in this area and identify the ways forward that could be used by all partners.

The solid body evolution and growth modeling area

It should be explained why the research area of choice for the BATEAU project is solid body evolution and growth modeling and what is its potential.

This was the area of choice because PUT, UL, TUDO already had a good collaboration in this very area and it was judged to be very promising. TWINNING was seen as a perfect tool to push further and to deepen this collaboration. UL has organized in 2013, together with TUDO, a Summer School in the same area – its title was: "Evolutionary Solid Bodies. Growth and Remodeling of Biological Tissues". A representative of PUT took part in this School (it was not possible to send any more people because of the budget issues). The topics during this Summer School combined two main scientific domains that are now covered by the BATEAU proposal, which are biology and engineering. In both those domains the important scientific aspects were the models of evolutionary solid bodies from biological and engineering point of view.

The solid body evolution and growth modeling thus encompasses those two aspects, which have entered into the realm of continuum mechanics in the 1990's. Thereby, one attempts to incorporate time-dependent phenomena, basically consisting of a variation of material properties, mass, shape and topology of the solid body. The tools needed for the enlargement of the continuum classical framework assumptions introduced in Truesdell & Noll (1965, 2004) to handle these biological phenomena are still under elaboration, and involve the following fields or approaches (the list is not exhaustive):

- open systems thermodynamics,
- configurational mechanics,
- mixture theory,
- biological evolution in relation to the mechanobiology of the cell,
- Shape and topology optimization in relation to functional adaptation,
- multiscale approaches, homogenization techniques.

Although the engineer is used to design optimal structures by modifying its design parameters, shape or topology, modifications by the engineer that can interpreted as design evolution have not been modelled as a time-dependent process. The scientific idea behind the project is then to work out the common fundamentals in both theory and computation of structural optimization and biological evolution. One main objective of the project is to unify the computational techniques known in structural optimization and combine them with rigorous mechanical models for open systems and modifications in material space, which are typical for biological systems.

The perfect illustration of these concepts flow is modeling of the phenomenon of trabecular bone functional adaptation. UL developed models for bone internal and external remodeling at both trabecular and macroscopic levels, based on a description of the modification of internal density and the evolution of the surface of trabeculae due to mechanical and chemical stimuli (Figure 1). The growth model itself originates from principles of structural optimization, especially the driving force for the evolution of bone microstructure is related to Eshelby stress in configurational mechanics, a concept widely used to drive evolution of the design in structural optimization.

The models and simulation tools that have been developed can in the future be extended for the purpose of computing optimal structures in engineering based on such biomimetic principles.

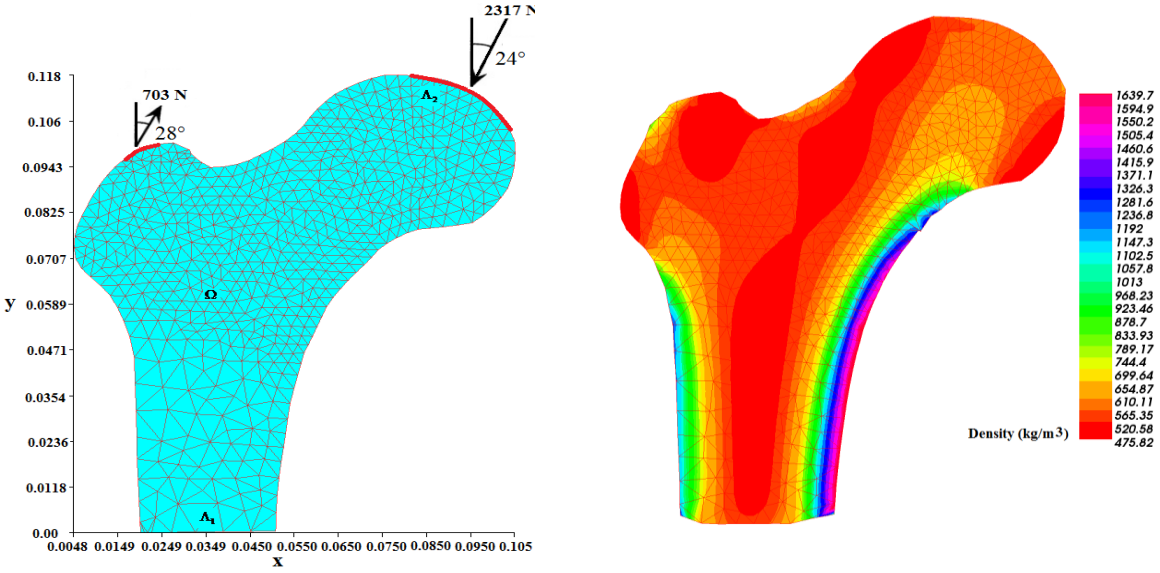


Figure 1 Simulation of the evolution of bone internal density distribution due to internal remodeling based on optimization principles from structural engineering

Conversely, PUT developed biomimetic optimization inspired from the previous bone remodeling algorithm, as illustrated on Figure 7.

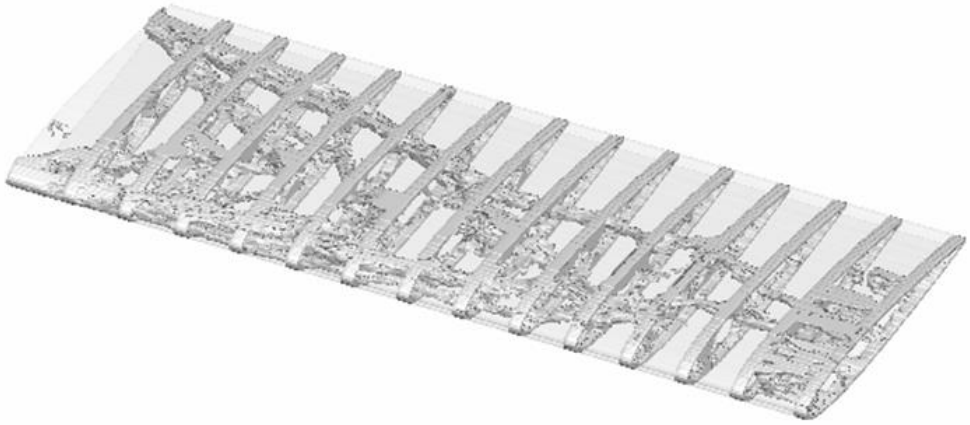


Figure 3 Biomimetic optimization (inspired from the bone remodeling algorithm). Optimal internal structure for the NACA0012 wing profile computed in the aeroelastic numerical environment

The area of solid body evolution and growth modeling has three main subareas:

– Biological tissues,

- Materials,
- Optimization.

The common denominator of those three subareas about the solid body evolution and growth area is modeling of solid body evolution in time leading it to achieve a definite result. These subareas are highly correlated. In the tissues subarea the focus is on real evolution in construction and structure of living organism's tissues. In the materials subarea the focus is on using the same methods and models for designing new materials, for the use in medicine, as well as in all uses where the way of getting a material of required characteristics is important. In the optimization subarea the crucial thing is the adaptation and optimization of solid continua and structures.

PUT strengths

PUT has an immense potential in solid body evolution and growth modeling. PUT Chair of Virtual Engineering developed the structural optimization system that allows the simultaneous optimization of size, shape and topology useful in industrial applications. The basis and the primary idea for the formulation of algorithms was bone remodeling phenomenon leading to optimization of the trabecular network within bone. The idea was formalized with theorems concerning surface constant strain energy principle to form the biomimetic optimization system. On the other hand, the methods and tools developed for purely industrial applications like Finite Element mesh parallel generation and parallel structural analysis computational environment allow now the effective analysis of biological structures evolution and growth. The extension of this way of thinking can benefit to a wider range of applications and areas, which will be the basis for cooperation in the project. Especially, concepts and models of new materials with unique features based on an optimal microstructure including metamaterials could be developed and transferred to the field of biomedical engineering.

Professor Michał Nowak (BATEAU leader) did contribute to the creation of a course BioCAD, which was a common Initiative between the UL partner, Poznań University of Technology, Gdansk University of Technology (GUT, Poland), Gdansk Medical University (GUMed, Poland) and Bremen University, with the purpose to open in september 2018 a Master course.

The interest of PUT in the areas of solid body evolution and growth modeling is in line with some other initiatives that have been undertaken at PUT in the recent years and concerning the reserach on joint aspects from the fields of biology and engineering.

PUT has a good collaboration with Rehasport Clinic. The Rehasport Clinic team consists of orthopedists, radiologists, physicians, sports medicine doctors, rehabilitation physicians, surgeons, internists, physical therapists, but also the coaches of physical preparation, biomechanics, psychologists, nutritionists and sports managers. Most of the engaged teams are have a strong experience in research oriented projects. Rehasport Clinic provides the highest medical competence in the area of orthopedics, diagnostic imaging and rehabilitation. Rehasport Clinic specialists have, among others, taken care of members of the Polish Olympic team in Beijing and London. They are also members of the Medical Commission of the Polish Football Association. Members of the clinic will be fully engaged to the task of medical data analysis and possible appliances in the field of orthopaedic reconstructions, rapid prototyping supported surgeries.

PUT research gaps and weaknesses

The main research gaps of PUT and thus the principal areas of interest of **Poznan University of Technology** in the BATEAU project are the following:

- 'Homogenization and optimization' The purpose of this part is to expose discrete homogenization methods developed to construct the effective continuum behavior of initially discrete structures or materials.
- Methods and algorithms for shape and topology optimization problems.
- Internal evolution of solid bodies due to growth phenomena.
- Modeling of trabecular bone functional adaptation evolution including the bone tissue behavior.
- Structural optimization based on trabecular bone remodeling phenomena.- Bone mechanics: computation of effective mechanical (static and dynamic) properties.
- Orthopedic surgeries - lumbar spine surgery - bioengineering (collaboration with biologists, medical doctors, surgeons).
- Bone metabolism - bone turnover - bioengineering (collaboration with biologists, medical doctors, rheumatologist).
- Modeling of bony parts of skeleton - lacking head of femoral bone, lacking condyle of the knee joint due to osteomyelitis (infection of bone in newborns).
- Prepation stage for future fabrication of lacking parts with chondroblasts culture over a 3D shaped model.
- Stability of titanium spine implants (screws) in low quality osteoporotic bone (osteogenesis imperfecta, cerebral palsy, myelomeningocele).
- Forces of intraoperative correction of spinal deformity in adults after compression fractures.

These areas are covered by Western Europe consortium partners who are willing to cooperate with PUT. Each of those internationally-leading institutions has particular excellence in one of the above-mentioned subareas in the area of solid body evolution and growth modeling and they will be in charge of excellence transfer to PUT within BATEAU in those subareas, i.e.:

- Tissues – University of Lorraine, group of professor Jean-François Ganghoffer.
- Materials - The International Research Center for Mathematics & Mechanics of Complex Systems (M&MoCS), group of professor Francesco dell'Isola,
- Optimization – TU Dortmund University, group of professor Andreas Menzel.

PUT also has some other weaknesses that make it is still in the group of low performing research institutions and these are:

(1) Low level of publications

PUT only has two publications in the area covered by the project in good scientific journals. How BATEAU will help: deepening personal and scientific relations with the excellent researchers from abroad will certainly increase the number of joint research activities and thus also the number of joint papers. Partners publish a lot in high impact journals and they will help PUT in doing so to.

(2) Low performance in acquiring research funds

How BATEAU will help: BATEAU will strengthen PUT in this area, since PUT will build stronger connections with 3 internationally-leading institutions with which PUT will apply for funds and also because it is foreseen within the project activities that the Western partners will share their knowledge with PUT related to funds acquiring.

(3) Lack of scientific contacts between researcher at the same level and between students (as future possible researchers)

There is still little cooperation between the PUT researchers with the researchers in the foreign, good universities, which makes that there are no research ideas exchange, no synergy effect. This goes to professors, assistant professors but also to students – and the student who stay at the university will become the researchers that will choose to work in a local, hermetic group, instead of being open to fresh ideas and contacts.

How BATEAU will help: there will be staff exchange and expert visits in the project, which will also cover the students and this is a great opportunity to both stimulate the personal and scientific contacts between researchers, as well as different other activities that will help in this matter (Summer Schools, Seminars etc.).

(4) Mental barrier and language barrier as regards working with people from other countries

This weakness is similar to the previous one, but still different. The language is a big barrier in entering in relationships with the people from abroad, even if the young generation's language skills are getting always better.

How BATEAU will help: by stimulating the personal contacts between the PUT team and the researchers from abroad it will be an important motivation for the PUT team to enhance their language skills (mainly in English) and also during such contact those skills will certainly get better.

(5) Lack of knowledge and experience on how to commercialize the research results and how to cooperate with the industry.

It is very important that the research is executed with the awareness of what is important for the industry and the PUT team does not yet have satisfactory relationships with the local (or other) business. PUT lacks knowledge and experience on how to commercialize the research results, while this is one of the crucial abilities in order to be able to well exploit the research results and so that the research and industry be strongly linked. PUT does put a lot of effort in starting and maintaining good relationships with the industry and it has some good results in such a collaboration, but it still feels there is a lot more to be learnt for it in this area.

How BATEAU will help: the internationally-leading institutions in BATEAU have a good experience in starting and maintaining contacts with the industry and they will share their knowledge with the PUT team.

Detailed presentation of project objectives

The main goal of the BATEAU project is:

Excellence transfer to PUT in the solid body evolution and

growth modeling research area based on the idea of concepts flow from

biological and medical sciences to engineering and vice versa.

The driving idea standing behind the project – to enhance the research capabilities of the PUT within the area of the solid body evolution and growth modeling and their applications in biology and medicine – is to be accomplished by establishing (basing on the links already tied up) a cooperative net between the university and the three leading European research centers, located in France, Italy and Germany. It is expected that the project will result in a better understanding of the processes which determine solid body evolution and, consequently, will enable developing better numerical tools necessary to model and simulate processes of its grow. Furthermore, the project is also to support educational activities at PUT by letting the Ph.D. and advanced M.Sc. students from PUT to take an advantage of knowledge and experience which the foreign partners of the project are willing to share with their Polish counterparts. Besides scientific, numerical, and educational aspects, an important role is also played by objectives concerned with organizational and administrative issues,

focused on an enhancement of non-technical capacities of PUT (shortly described in Objective 6 below).

Seven supporting objectives of the project are shortly described in what follows.

Objective 1: To enhance the scientific and technological (S&T) capacity of PUT.

PUT is a research center with high potential and ambitions in the fields of solid body evolution and growth modeling but it has some gaps that have to be overcome and this will happen within the frames of the BATEAU project. The research gaps have been specified and the research intensive partners have been chosen as the best to help PUT to fill these gaps. When the S&T capacity of PUT increases, PUT will be able to run the research of a higher quality and it will become a real and strong partner for other institutions active in this field.

Objective 2: To enhance the non-technical capacities of PUT.

In the recent years, a visible trend is observed within the Polish system of financing research activities that founds obtained from various external sources play more and more important role. This trend requires that the academia quickly adjusts to the new situation and becomes competitive in obtaining bailouts not only within national, but also (or even first of all) European scientific community. However, an efficiency in elicitation of founds depends not only on the quality of research of a given academic center, but also on the non-technical capacities of its employees. The non-technical capacities are understood here as all relevant administrative-like abilities from identifying possible sources of funds, through project consortia building and application writing, to project management. It is clear that instead of a “trial and error” path to acquire the necessary capabilities, it is much more efficient to base this capacity-gaining process on the flow of the corresponding experience and knowledge from leading European academic centers to PUT. Thus, an enhancement of the non-technical capacities of PUT, resulting from a close cooperation with UL, M&MOCS, and TUDO, each of which has an extensive experience in an external founds leverage, is among important objectives of the project.

Objective 3: To raise partner institutions staff’s research profile.

The first and main aim is to raise PUT staff’s research profile. This is very much related to Objective 1, as stronger staff means stronger institution. But the focus needs to specifically be on raising the research profile of individual researchers from the PUT team, at all levels – professors, adjuncts (assistant professors), and assistants. They will greatly benefit from individual visits they will perform in partner institutions, as well as from the visits of professors from those institutions at PUT, from all the events organized within the project – Summer Schools, Thematic Workshops, good external conferences they will attend etc. But the aim also is to raise other partner institutions staff’s research profile, which will naturally happen for the team members involved in the project. The research area of the solid body evolution and growth modeling combines knowledge and methods of different sciences, from biology and medicine to engineering. Thus, making an important contribution to the area is indeed a challenge which requires joint effort of researchers having different roots. However, building a possibly comprehensive consortium of well-motivated scientists having complementary competences, offers unique opportunities to raise research profiles of their home institutions just by stimulating a flow of knowledge and experience among the partners. Since the partners of the project are definitely not short of motivation and necessary competences, it is believed that this objective will be successfully accomplished.

Objective 4: To enhance the scientific and technological (S&T) capacities of the other project partners.

It is important that not only PUT, but also UL, M&MOCS, and TUDO take advantage of the course and outcomes of the project, fulfiling the tasks which without the project would be out of reach. For this reason, the partner institutions were chosen in such a way that their overall technical capabilities, as well as knowledge and experience of their staffs, complement each other. It is expected that the

project execution will be based on strong personal contacts resulting in a continuous flow of knowledge and experience among the four universities. Provided that the project is successfully completed, at its end each of partners shall enjoy the fact that his/her scientific capabilities (as well as knowledge about available relevant technological solutions) are distinctly more comprehensive than at its kick-off.

Objective 5: To strengthen the research area of the solid body evolution and growth modeling.

The area of the solid body evolution and growth modeling is relatively new and, as the time passes, attracts more and more attention from academia and industry. However, due to the fact that it lies on an intersection of a number of quite distant research areas, it is indeed a challenge for individual researchers or small academic centers to get involved in it. In consequence, the community of the researchers actively contributing to its development is relatively narrow. It is expected that the project, with its diverse activities, will result in strengthening of the research area of the solid body evolution and growth modeling by attracting further resources (human, financial, and technological), which would enable its constant and rapid progress.

Objective 6: To stimulate innovation in the area of the solid body evolution and growth modeling.

This objective is closely linked to the previous one. The area of the solid body evolution and growth modeling is a very promising and attractive research branch with an extraordinary potential concerning its possible applications. However, it its founded on the basis of so different fields of research that any innovative solutions are proposed here much less often than in other areas of applied research being at a similar level of development. The project, is aimed at stimulating an innovation flow from widely understood research community towards the area of the solid body evolution and growth modeling, on the one hand, by shedding light on the opportunities it offers and popularizing its findings, and, on the other hand, by exposing the challenges and needs it faces.

Objective 7: To build a sustainable network of institutions involved in the research in the solid body evolution and growth modeling.

The multi-faceted specificity of the area of the solid body evolution and growth modeling means that a combined effort of several different sciences is necessary to ensure its development. Having this fact in mind, it is planned that the project will establish a sustainable international net of academic centers, research institutes, and other institutions interested in the area and its progress. The cornerstone of the net is to be the four nod network linking PUT, UL, M&MOCS, and TUDO established within the project. It is expected, though, that the net will last and develop also after the project is completed, gathering consequently more and more entities attracted by visible advantages which the net offers.

The success measures of the project that are at the same time the project activities are as follows:

- 27 expert visits will be performed, 3 per year per each of the three foreign partner institutions, each lasting one week (professors from UL, M&MOCS and TUDO will come to PUT),
- 30 staff visits will be performed, each lasting one week (Polish researchers - professors, adjuncts (assistant professors), and assistants - go to foreign universities),
- 45 student visits will be performed, each lasting 2 weeks (Polish students go to foreign universities),
- 3 thematic workshops will be organized, each being a half a day event, for project partners and other experts in the research area, each by one internationally-leading partner (UL, M&MOCS and TUDO),
- 3 Summer Schools will be organized, each lasting 3-5 days, for PhD students and M.Sc. students from PUT mainly, but also from other partner organisations, each by one internationally-leading partner (UL, M&MOCS and TUDO),

- 3 Study Sessions will be organized in Poland, for PUT students, with the aim to train them to write good scientific papers,
- An e-learning platform will be created and filled with content (materials useful to raise excellence in the research area covered by the project),
- A new specialization course on Biomechanics will be created at PUT,
- The project website will be created,
- 15 scientific papers will be published in reputable journals/conferences,
- At least 50 visits at conferences, seminars, workshops whose scopes of interests are related to the topic of the project will take place (1 visit: 1 person participating).

Several other success measures of the project have been defined:

- the number of submitted applications for external funds (projects, grants) by the Faculty of Machines and Transportation and Faculty of Civil Engineering of PUT as a result of the BATEAU project activities: 2 such applications will be submitted.
  Even now there already are a number of possible schemes/programmes within which such applications may be submitted, as e.g. the program of CNRS, the French national research center for creating an international laboratory without walls (created for structuring an existing collaboration between two institutions on a given topic) – http://www.cnrs.fr/derci/spip.php?article23 or the Personal Health Care H2020 Programme.
- the number of invited talks delivered by the Polish beneficiaries (the PUT project team) at important international conferences: 5 such talks will be given.
- the number of scientific promotions (Ph.D. degree) obtained by the Polish beneficiaries during and after the project, in some relation with the BATEAU project activities: there will be one Ph.D. degree promotion.

The benefits of partnering institutions from the project is clear and straightforward and will be constantly updated. The updates will be send to the all team members, will be spread among partnering institutions stake holders and finally to the larger audience by social media and other popular communication channels.

The above-mentioned success measures being the important project activities perfectly correspond to the project Objectives. It has been specified below which Objectives are addressed by the specific activities and in what way. It has to be underlined that the Objectives are very much interrelated and all the activities address a great deal of them. The aim of the explanations below is to highlight the most obvious links between the activities and the Objectives, and not to exhaustively explain it, since much of the information from the other sections of the project would have to be unnecessarily repeated.

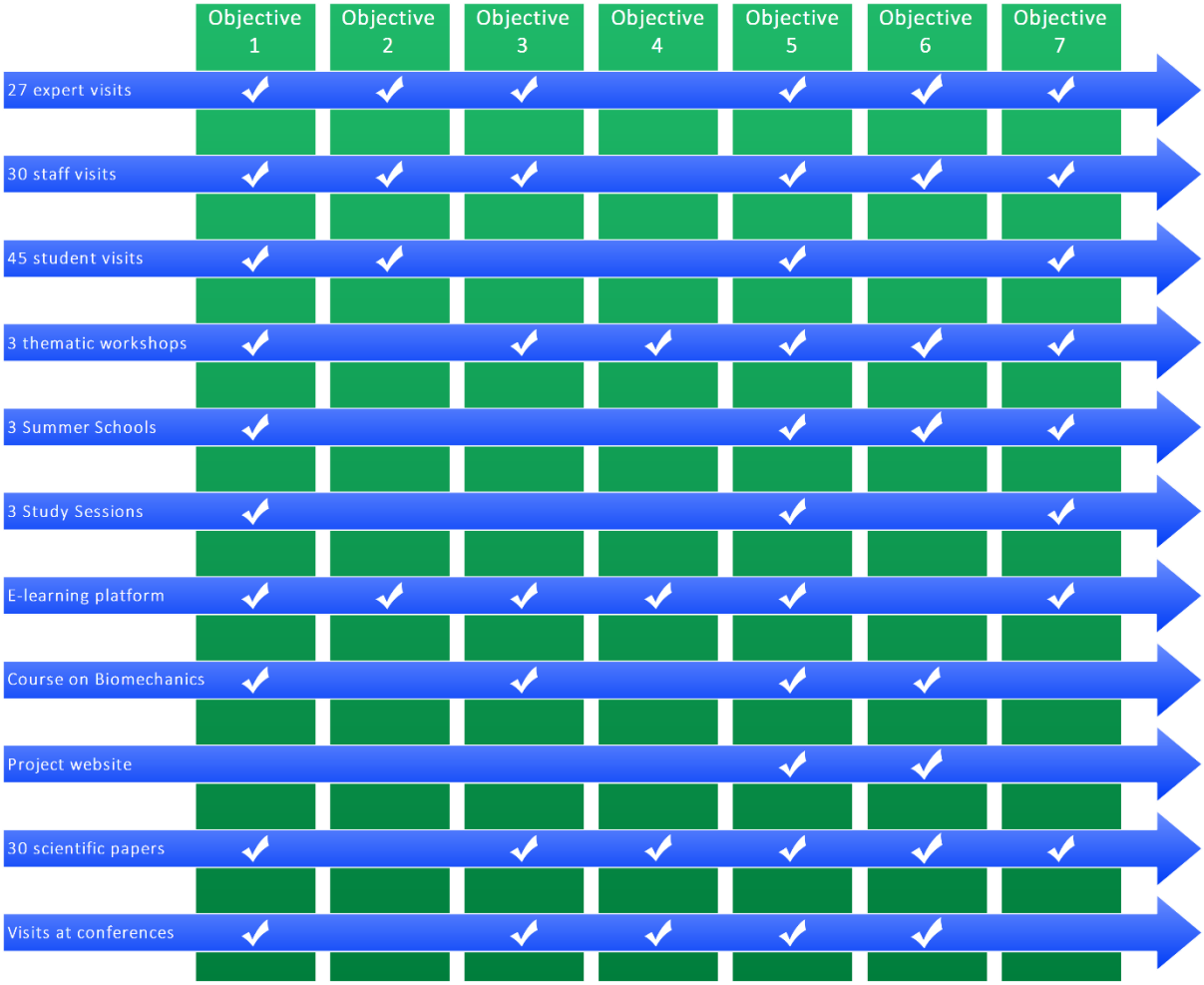


Figure 2 Project activities' contribution to project Objectives

As can be seen on Figure 2, almost all success measures are linked to Objective 1. The only exception is the measure dealing with the project's website, which is clearly not directly connected with an enhancement of the scientific and technological capacity of PUT, standing behind Objective 1. A little different situation can be observed with respect to Objective 2, which is connected with only four measures (it is in fact the minimal number of measures attributed to an objective; also Objective 4 is linked to four measures). This fact can be explained by an observation that Objective 2, focused on an enhancement of the non-technical capacities of PUT, is concerned with a flow of knowledge and experience towards PUT realized exclusively within contacts among the partners devoted solely to the project (i.e., during staff and students exchange and via the e-learning platform). Seven success measures are attributed to Objective 3, aimed at raising partner institutions staff's research profile. In this case, the measures are quite diverse, from staff exchange, through workshops and conferences, to e-learning platform, course on Biomechanics, and scientific papers. It is clear that not included in this set are all activities concentrated on an involvement of students as well as the project's website.

As already mentioned, Objective 4, dealing with an enhancement of the scientific and technological capacities of the other project partners, is linked to four measures. It is in accordance with expectations that each of these measures is devoted to an exchange of highly specialized knowledge among qualified experts in the research area of interest, which most likely takes place at workshops and conferences or via scientific papers. In the case of BATEAU, a contribution to Objective 4 is attributed also to the e-learning platform. Objective 5, i.e., strengthening of the research area of the solid body evolution and growth modeling, is the only one which is linked to all eight success measures. This fact should not be surprising, for achieving this objective seems to be a natural consequence of a

successful conclusion of the whole project. After all, an excellence transfer to PUT by the concepts flow from biological and medical sciences to engineering and vice versa, constituting the title of BATEAU, is an explicit instance of strengthening of the research area of the solid body evolution and growth modeling.

Each of the remaining two objectives, i.e., Objectives 6 and 7, is attributed to eight success measures. The former of them, aimed at stimulating innovation in the area of the solid body evolution and growth modeling, is not linked to the students visits, study sessions, and e-learning platform, which indeed seem to have a negligible impact on its fulfilment. The latter objective, devoted to building of a sustainable network of institutions involved in the research in the area of the solid body evolution and growth modeling, is to a large extent not related to the course of Biomechanics, project's website, and visits at conferences. Actually, it can be argued whether the project's website and participation in conferences do not support building of a sustainable network of institutions, but it should be admitted that an influence of these two factors is definitely smaller than the influence of the activities standing behind the remaining eight success measures which are linked to Objective 7 on Figure 2.

1.2 Relation to the work programme

In the TWINNING topic description the specific challenge is defined as follows: "to address networking gaps and deficiencies between the research institutions of the low performing Member States and regions and internationally-leading counterparts at EU level". It is explained in the call text that the leading research centers tend to link to other similar, equally successful, institutions, which makes the less-developed research centers are put aside, even if they have a good potential for growth and for becoming valuable knowledge and innovation contributor.

Call text objectives	BATEAU objectives
Specific challenge: The specific challenge is to address networking gaps and deficiencies between the research institutions of the low performing Member States and regions and internationally-leading counterparts at EU level.	BATEAU main objective is **to transfer excellence to PUT concerning concepts flow from biological and medical sciences to engineering and vice versa in the area of solid body evolution and growth modeling**. PUT is the research institution from a low performing Member State that has a great research potential in the fields of solid body evolution and growth modeling but which needs the support and stimulation from some strong leading research institutions. UL in France, M&MOCS in Italy and TUDO in Germany are three internationally-leading research institutions in the area covered by the project. The networking gaps and deficiencies of PUT are related to lower S&T capacity of PUT in certain areas related to solid body evolution and growth modeling, and thus one of the project objectives is **"to enhance the scientific and technological (S&T) capacity of PUT" (Objective 1).** They are also related to non-technical capacities of PUT, which is why one other objective is **"to enhance the non-technical capacities of PUT" (Objective 2).**

	When PUT networking gaps and deficiencies are well addressed, PUT will get stronger as a potential partner. UL, M&MOCS and TUDO appreciate the potential of PUT and wish to undertake the actions within the BATEAU project in order to tighten the cooperation with PUT and to make it a solid partner for future joint research initiatives. This is why one of the project objective is **"to build a sustainable network of institutions involved in the research in the solid body evolution and growth modeling" (Objective 7).** It should be highlighted here that the partners had a previous experience of a joint work in other projects, which will surely help in achieving success of BATEAU project, as a natural and spontaneously planned continuation of previous cooperation.
Scope: Twinning aims at significantly strengthening a defined field of research in a particular knowledge institution (a research active university or a public research organisation or a private non-profit research organisation) by creating a link between this institution and at least two internationally-leading research institutions in other Member States. Twinning will: • Enhance the S&T capacity of the linked institutions; • Help raise staff's research profile as well as the one of the institutions involved.	**BATEAU will significantly strengthen the solid body evolution and growth modeling field of research in Poznan University of Technology – Objective 5** of the project is **"to strengthen the research area of the solid body evolution and growth modeling".** Another objective very close to this one is **"to stimulate innovation in the area of the solid body evolution and growth modeling" (Objective 6).** This will be the result of the link created between PUT and three leading institutions in this area, i.e. UL in France, M&MOCS in Italy and TUDO in Germany and this will happen because of the increase in S&T capacity of the linked institutions and through staff's raised research profile and thus the specific objectives have been defined as follows: **"to enhance the scientific and technological (S&T) capacity of PUT" (Objective 1)**, **"to enhance the scientific and technological (S&T) capacities of the other project partners" (Objective 4)** and **"to raise partner institutions staff's research profile" (Objective 3)**. It is clear that the project will be beneficial not only for PUT but also for the other parties involved in the project.

1.3 Concept and approach, quality of the coordination and support measures

Within the project the PUT's research gaps and weaknesses specified in section 1.1 will be addressed. As said before, the Western European partners will transfer their expertise to PUT in the following subareas of the solid body evolution and growth modeling area:

- Tissues – University of Lorraine, group of professor Jean-François Ganghoffer.
- Materials - The International Research Center for Mathematics & Mechanics of Complex Systems (M&MoCS), group of professor Francesco dell'Isola,
- Optimization – TU Dortmund University, group of professor Andreas Menzel.

UL, M&MOCS and TUDO have a great excellence in the research area covered by the project and they are renowned research centers at the European level. The excellence of partners, the complementarity of their expertise in the light of the project and their previous cooperation has been described in more details in section 3.3.

The research area covered by the BATEAU project is important for both the country and the region, in particular with so-called smart specializations:

- At the European Community level (linked with the Europe 2020 Strategy) it contributes to the EU Priorities :
    - Public health & security,
    - Public health & well-being,
- In scope of the national level, it contributes to the Polish national Smart Specializations:
    - HEALTHY SOCIETY: Medical engineering technologies, including biotechnologies and
    - INNOVATIVE TECHNOLOGIES AND INDUSTRIAL PROCESSES (HORIZONTAL APPROACH): Smart creative technologies.
- Greater Poland (Wielkopolska Voivodeship) Smart Specializations:
    - Development based on ICT especially in field of specialist ICT tools and products for the areas of expertise of the region,
    - Modern medical technologies supporting products, services and new technologies related to the prevention, diagnosis and therapy of civilization diseases and rare diseases and new methods of supporting diagnostic and therapeutic decisions using ICT and Big Data.
- It is in line with the Poznan University of Technology strategy of developing up to year 2020. The strategy indicates actions that should be taken by the Poznan University of Technology to permanently strengthen its position in the Polish and European educational space and to enhance the ability to compete with universities in Poland and abroad in the field of education, scientific and research and development by the year 2020.

The approach adopted in the project has been chosen in order to obtain the best possible results. The focus in the project is, in the first place, on personal contact between researchers. It is clear that good personal relations fructify in undertaking joint initiatives and research work. This is why the important part of the project is **staff exchange**, where the researchers and students from PUT will go to the Western Europe partner institutions. Within the staff exchange activity professors and experts from the Western research centers will also come to Poznan. This is the perfect channel to transfer expertise to PUT. Also, the stays of foreign professors and experts at PUT is one of the pillars of the project – they will take place once a month (and last a week) and the visitors will give lectures on the topics covered by the project.

Another tool of capacities transfer are **Thematic Workshops** – three such workshops will be organized on the research subjects related to the research area covered by the project, gathering top experts in the area of the solid body evolution and growth modeling. Each workshop will be organized by one of the internationally-leading partners.

Three **Summer Schools** will also be organized – again, each by one of the Western Europe partners. The Schools will be addressed to Ph.D. students and M.Sc. students from PUT and will concern the topics covered by the project research area. Students from the other partner institutions will also be

warmly welcome so that the Schools become a good platform for building relationships between students (both formal, like e.g. starting new research projects, and informal).

Another important channel for excellence transfer are **Study Sessions** that will be organized in Poland for PUT students and they will be led by the partners from abroad, with the aim to train the PUT students to write good scientific papers. It is planned that the students will work with their tutors on their own papers and that the result of the Study Sessions will be the papers that will be submitted for publication to technical journals. This channel will thus bring the Polish students both the technical knowledge on how to write good papers and will also ensure them the guidance of professors from foreign research centers in the research aspect of their work on the papers.

In order to fortify the effect of the excellence transfer within the project, it has been planned that an **e-learning platform** will be created, containing the materials from different project activities, such as Thematic Workshops, Summer Schools etc. The materials will be available for all interested people involved in the project, and mainly for the Ph.D. and advanced M.Sc. students at PUT. In addition, the materials will be carefully prepared in order to keep the standard of good e-learning materials, so that the work with them be the most attractive and effective possible for students. This way the excellence transferred to PUT via different channels will be more grounded, as students will have the opportunity to work more intensively on the subjects of their interest and it will also be available for students that – for some reason – missed the lectures at e.g. Summer Schools and for students that will come to PUT in the next years.

An important activity aiming at capacities transfer is the preparation of the Biomechanics Specialization Course at PUT, at the Faculty of Machines and Transportation. The Biomechanics specialization course will be the continuation of the trend at PUT to explore the new research area joining biology and technical aspects (engineering). Similar cooperation has already been undertaken by the project partners, when a course in the similar reserach area was created at the University of Lorrain in Metz, with the participation of the PUT (e.g. of prof. Michał Nowak, the leader of BATEAU). The course will be prepared within the project (with the detailed curriculum, description of lectures, student manuals etc.), each partner contributing with its own specific expertise. The Biomechanics Specialization Course will be opened after the project's end and it is estimated that ca. 40% of courses will be provided by lecturers from outside PUT.

There have also been planned the **dissemination and exploitation activities** within the project, in order to increase scientific visibility of PUT as a strong research center in the area of solid body evolution and growth modelling and to disseminate the information on the project and exploit its results. The project webpage will be created, the scientific papers will be published in reputable journals. Partners will also participate in conferences, seminars, and workshops organized in the research areas close to the one covered by BATEAU.

All the project activities are explained in more details in section 3.1.

It may be explained here that the project would like to have a positive impact on equal status of men and women. There are several women that will be involved in the project as the research staff in PUT and in the other partners' institutions. The project assumes to follow the rule of equal men and women status when involving Ph.D. and graduate students into the project activities.

2. Impact

2.1. Expected Impacts

Expected impacts of BATEAU can be classified in three different, though not sharply disjoint, categories, which cover impacts concerned with (i) personal, (ii) institutional, and (iii) regional issues. Each of the categories matches very well to the aims of the TWINNING programme which were specified in the TWINNING topic description in the following way:

There will be a measurable and significant improvement in the overall scientific and innovation capacity of the initiating institution in a particular r field of research through linking with research intensive counterpart institutions in other Member States and thereby expect positive impacts on the overall research and innovation potential of the Member State or the region the initiating institution is located in. Such improvement could be measured through an increase of peer-reviewed publications, increased impact factors in terms of citations etc.

The central role in BATEAU is played by PUT, which is the "initiating" institution, and all of the activities to be carried out within the project are aimed at its "significant improvement in the overall scientific and innovation capacity". However, an improvement of the scientific and innovation capacity of any academic institution can be achieved only by an improvement of such capacities of its staff. In consequence, BATEAU is to have a strong impact on every single person taking part in it. On the other end, PUT is located in Poznań, one of the largest Polish centers of industry, education, technology, culture, trade, tourism, sports, and particularly important academic center, with about 130,000 students. This means that an "improvement in the scientific and innovation capacity" of PUT, one of the biggest universities in Poznań, will likely have an impact on the city and the whole Greater Poland (Wielkopolska) Voivodeship, to which Poznań is the capital. In what follows more precise information dealing with impacts concerned with (i) personal, (ii) institutional, and (iii) regional issues are provided.

Impacts concerned with personal issues

The list of impacts on the personal level is long and concerns all of the partners taking part in the project. One of the expected (and measurable) outcomes of the project is an increase of the number of publications in highly ranked (with high impact factors) journals authored by the members of the projects' consortium. Such an increase will likely lead to an increase of individual Hirsch indexes of the project partners, which is one of the factors taken into account when one's scientific achievements are evaluated (e.g., when seeking for a position at an academic institution or applying for a scientific degree or title). Furthermore, the number of papers, their quality, and the number of citations are taken into account also in other procedures, for instance in assessments of applications for grants, projects, awards (e.g., annual awards given to distinguished employees by a rector of each Polish university).

A participation in an international project can have particularly strong impact on the careers of young researchers from PUT, i.e., Ph.D. and advanced M.Sc. students. Close, regular, and long-standing cooperation with reputable researchers from abroad can not only broaden their knowledge and experience, enrich their record of publications, but also generally improve their CVs, enhancing their chances to find good jobs in academia or research-related industrial institutions. BATEAU would provide the students with a chance to establish sustainable personal links with internationally known researchers which may prove to be extremely valuable in further steps on their academic careers (e.g., a support from one, two, three (or even more) known researchers is usually necessary when one applies for a postdoc position or prestigious grants like the German Alexander von Humboldt Fellowship).

Impacts concerned with institutional issues

The focal impact of BATEAU will be dealing with the excellence transfer to PUT as the initiating institution. After all, the main idea of the project is to enhance the capabilities of PUT as an academic and research center in the area of the solid body evolution and growth modeling on both national and international levels. Creating a net spanned, besides PUT, by UL, M&MOCS, and TUDO, and exploiting it to stream knowledge, expertise, and experience towards PUT, in particular towards its Faculty of Machines and Transportation and Faculty of Civil Engineering, is to noticeably improve capabilities, standings, and visibility of the university. As a consequence (which was already mentioned above), the number and quality of scientific publications authored and coauthored by the Faculty staff should distinctly increase. Since these factors play a crucial role in categorizing of academic institutions in the Polish national system, which is directly connected with the financing algorithm, it is believed that the

participation in the project will magnify financial support to PUT from the ministerial budget. It is noteworthy that participation in BATEAU would probably improve a financial situation of PUT also due to the fact that competitive abilities of the university in elicitation of external grants and projects would significantly increase as well.

Another point is concerned with the fact that the topic of the project combines knowledge, specifications, and needs of various research areas, from engineering, through biological, to medical sciences. For this reason, among the project beneficiaries are also scientists from two other universities in Poznań, namely from the Faculty of Biology of the Adam Mickiewicz University and the Faculty of Medicine and Faculty of Health Sciences of the Poznań University of Medical Sciences. A successful cooperation between these three Faculties and the Faculty of Machines and Transportation from PUT has already been carried out, and one of the targets on which the joint efforts were focused dealt with construction and usage of medical, diagnostic, and rehabilitation equipment. It is expected that BATEAU would provide an additional strong impulse to amplify the concepts flow from biological and medical sciences to engineering and vice versa, and make further progress in the research area of common societal interest having direct links to industry.

It is expected that the closer cooperation between project partners will result in stimulation of development of theoretical basis for solid body evolution and growth modeling. It is also planned that such cooperation will result in development of digital tools for solid body evolution and growth modeling.

As regards the new course on Biomechanics that will be created within BATEAU, the results of the work on the course will feed the proposal that will be submitted within the POWER programme, being one of the Operational Programmes for 2014-2020. POWER (Operational Programme Knowledge, Education and Development) will aim to improve the quality and efficiency of the Polish higher education system and is funded within the European Social Fund (ESF). The aim of the proposal will be to create a Master degree course in Biomechanics (a special line in POWER is dedicated to such activities).

Impacts concerned with regional issues

BATEAU is focused on establishing a strong scientific cooperation between PUT and UL, M&MOCS, and TUDO based on tight personal links. The staff exchange planned within the project covers visits of experts from foreign universities at PUT (additionally there are also, so-called, Study Sessions scheduled within the project course aimed at training Polish students to write good scientific papers; the sessions are to be conducted by an expert from M&MOCS who will come for this purpose to Poznań). This will give the visitors from abroad a chance not only to work with their colleagues and students from PUT and become familiar with the specifications the university, but also will provide them with an opportunity to explore the attractions of the city of Poznań and its surroundings. Also an increasing scientific visibility of PUT in the area of the solid body evolution and growth modeling may lead to an explicit increase in the number of visits of researchers from abroad to Poznań to cooperate with their Polish colleagues or attend seminars or conferences. Very likely, such short visits will kindle an interest of the foreign partners (and their families) in the Greater Poland (Wielkopolska) Voivodeship and will result in further visits focused mostly on touristic purposes. There is no doubt that tourism can be a flywheel of the regional economy, providing profits to a given region and its inhabitants (need of hotels, restaurants, jobs, knowledge of languages, transportation infrastructure, etc.).

Another regional related impact concerns planned opening of a new specialization on Biomechanics at PUT within the Faculty of Machines and Transportation, which would also have visible consequences for the city of Poznań and the Greater Poland (Wielkopolska) Voivodeship. Among the presumable after-effects one may mention: attraction of new students to the town (need of dorms, cafeterias, increased interest in cultural and sport activities, development of infrastructure, e.g., transportation, sport venues, nurseries, kindergardens, hospitals, etc.). Moreover, in a longer

perspective a new, unique in Poland, specjalization may encourage representatives of industry which are interested in a cooperation with experts in the area of the solid body evolution and growth modeling to settle brunches of their companies in Poznań or its neighbourhoods.

It is believed that the impacts of BATEAU mentioned above with respect to all three categories of (i) personal, (ii) institutional, and (iii) regional issues will be observed in a long perspective, exceeding the duration of the project. Such a belief originates not only from the fact that in most cases real outcomes of any research activities are visible only with a certain delay, but mostly from the conviction that the net spanned by PUT, UL, M&MOCS, and TUDO will last much longer than the project's lifetime. Furthermore, it is hoped that the net will be extended by other institutions interested in progress of the research in the area of the solid body evolution and growth modeling.

2.2 Measures to maximise impact

2.2.1 DISSEMINATION AND EXPLOITATION OF RESULTS

Several different channels will be exploited to disseminate the outcomes of the project. Short descriptions of the main three of them are provided in what follows.

In order to reach a possibly wide audience, covering also persons only cursorily interested in the project's topic, the project web page will be created, say, in three month after its kick-off. The page will be stored on the servers of PUT and maintained by the team of the university. The web page will contain all relevant information about the project, its partners, course, status, results, challenges, and planned activities. Additionally, it is intended that other materials originating from the project's activities, such as presentations from advanced schools, will be available at the page as well. The page will be freely available to everyone and provide unlimited access to all its contents.

Another way to disseminate the outcomes of the project will be through articles published in reputable and commonly accessible (also open access) journals. There are quite a few prestigious peer-reviewed scientific periodicals where the results originating from the project can be published, among which one finds:

- Archive of Applied Mechanics (impact factor 1.438),
- Biomechanics and Modeling in Mechanobiology (impact factor 3.251),
- Composite Structures (impact factor 3.120),
- Computational Materials Science (impact factor 1.879),
- International Journal of Engineering Science (impact factor 2.291),
- International Journal of Plasticity (impact factor 5.971),
- International Journal of Solids and Structures (impact factor 2.035),
- Journal of Elasticity (impact factor 1.043),
- Journal of Mathematical Analysis and Applications (impact factor 1.119),
- Journal of the Mechanical Behavior of Biomedical Materials (impact factor 3.048),
- Journal of the Mechanics and Physics of Solids (impact factor 4.289),
- Mathematics and Mechanics of Solids (impact factor 0.860),
- Mechanics Research Communications (impact factor 1.495).
- Journal of the Mechanical Behavior of Biomedical Materials (impact factor 3.5).
- Journal of Biomechanics (impact factor 3.1).
- Biomechanics and Modeling in Mechanobiology (impact factor 3.2).

Each of the journals listed above is included in the base Web of Science. It is believed that around 30 articles will be written by the partners of the project and published still during its duration or shortly afterwards.

The third dissemination channel is via presentations at the conferences, seminars, and workshops whose scopes of interests are related to the topic of the project. Within the period of the project (and afterwards), the partners are to take part in various scientific meetings (organized at national and international levels) and whenever possible present the results which originated from the activities carried out within the project. The list of international conferences which are strongly related to the scope of the project interests consists (but is not limited to) of:

- Euromech (http://www.euromech.org/conferences),
- Ictam (http://www.ictam2016.org/),
- Wccm (http://www.wccm2016.org/),
- Solmech (http://www.solmech2016.ippt.pan.pl/),
- Cmm (www.pcm-cmm-2015.pg.gda.pl).

With respect to the exploitation of the project's outcomes, one should bear in mind that its main aim is to reinforce scientific capabilities of PUT in the area of solid body evolution and growth modeling. Hence, it is expected that at the end of the project the standings of the university on the competitive international level will be visibly improved which will be well reflected by a number of relevant factors. To be more precise, the level of success of the project can be estimated by monitoring the following measures each of which is based on individual activities and successes of the PUT employees:

- the number of research papers coauthored by the Polish beneficiaries published during and after the project,
- the number of grants realized at the Faculty of Machines and Transportation and Faculty of Civil Engineering of PUT after the project, as a result of the BATEAU project activities,
- the number of invited talks delivered by the Polish beneficiaries at important international conferences,
- the number of scientific promotions (professorships, habilitations, Ph.D. degrees) obtained by the Polish beneficiaries during and after the project, in some relation with the BATEAU project activities.

Another important measure of the level of success of the project concerns the PUT's Faculty of Machines and Transportation and Faculty of Civil Engineering as the academic entities dependent on the national system of financing research institutions. Within the system each of such institutions in Poland belongs to a certain category, which is determined basing on various criteria reflecting its scientific "power" (e.g., number of publications and patents, organized conferences, participation in grants, involvement of staff members in journals' editorial boards or other elected committees). Each of the institutions is very much interested in having the highest possible category, for higher category means more generous financial support from the national budget (and the differences between the categories are by no means symbolic). At present, the Faculty of Machines and Transportation and the Faculty of Mechanical Engineering possess category A, and make attempts to break through to category A+, while the Faculty of Civil Engineering wants to pass from category B to category A.

2.2.2 COMMUNICATION ACTIVITIES

The basic communication measure for promoting the project and its findings during the period of the grant will be the project's web page, with up-to-date information. Information on the project and its findings will also be communicated to external audience during the conferences, seminars and other events where consortium partners representatives will be present. They will either have presentations on the project (also as part of the scientific presentations they are planning to have, when presenting the scientific papers written within the project) or by informal conversations with the events participants and the distribution of project fliers.

3. Implementation

3.1 Work plan — Work packages, deliverables and milestones

The work within the BATEAU project is divided into 5 Work Packages. Four of them are devoted to the project activities which aim to realize all project objectives (Objective 1 to Objective 7), described in section 1.1. One of the WPs, numbered WP1, is connected with the overall project management and communication within the project. The relationship between the Work Packages is illustrated by the Figure 4 below.

The main goal of the BATEAU project is to transfer excellence to PUT in the solid body evolution and growth modeling research area based on the idea of concepts flow from biological and medical sciences to engineering and vice versa. This fundamental goal will be pursued by achieving objectives of four main WPs: WP2, WP3, WP4 and WP5. To transfer excellence and to durably enhance the area of solid body evolution and growth modeling a strong cooperation between the partners is needed, within and after the project. Therefore a great focus in the project is on personal contacts between the partners and on the strong partnership building (WP2). It should be also mentioned here that in order to strengthen this partnership the BATEAU partners aim to undertake some joint research activities and they will be looking for external funds for this purpose – but of course the research activities themselves are not funded from the Twinning program – the idea of flow concepts is shown in the figure above. Within WP2 the cooperation between the partners will be coordinated as regards the staff and students exchange, the Thematic Workshops, Summer Schools and Study Sessions, i.e. many channels through which the excellence will flow to PUT. Staff and students exchange will cover the visits of PUT professors, Ph.D. researchers, students, at the foreign universities, as well as the visits of the foreign professors at PUT. Sumer Schools will be dedicated mainly to students, as for strengthening of research capacity of an institution it is important to also train young researchers. Students will also be trained within the Study Sessions in writing good scientific papers. Thematic Workshops will be dedicated to high level researchers from the consortium, but the external researchers will also be very welcome and this will be the platform for them to exchange knowledge and ideas in most cutting-edge research topics within the solid body evolution and growth modeling area. Within WP4 a new specialization course on Biomechanics will be created, and it will be fed with input from WP2, i.e. staff exchange and different events organized within the project. On the other hand, the work on the course will influence and might give some guidance on the choice of topics to be covered within the staff exchange visits and for the project events (Summer Schools, Thematic Workshops etc.). WP2 will feed the e-learning platform, since the activities within WP2 are obviously the main source of the materials to be put at the platform. The materials on the platform and the platform itself may be useful for the work within WP4 – as regards the materials related to the area covered by the project but also the materials and the platform facilities aimed at stimulating the cooperation between the partners (space for exchanging information, materials etc.).

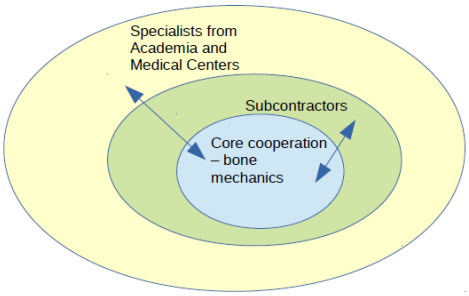
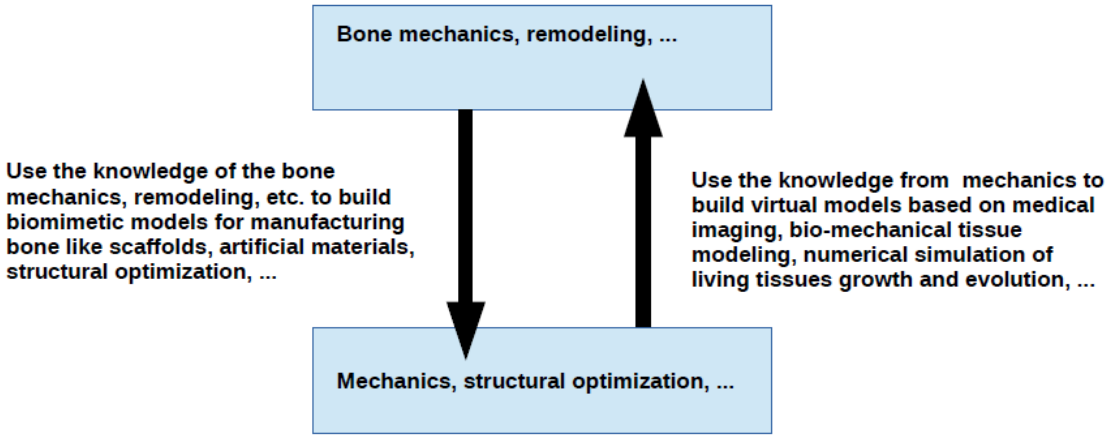


Figure 3
The idea of concepts flow in the BATEAU

The cooperation with the partners will take part on the three major levels:

Core cooperation – bone mechanics. Teams from France, Germany, Italy and Poland.
Specialists - from Academia and Medical Centers – mechanics, bone remodeling, tissue visualization, bio-mechanical modeling and simulation.
Subcontractors – source of medical data, medical imaging, projects.



Bateau project outcome new possibilities in :
- biomimetic models for manufacturing bone like scaffolds,
- manufacturing of artificial materials,
- structural optimization,
- virtual modeling based on medical imaging,
- bio-mechanical tissue modeling,
- numerical simulation of living tissues growth and evolution .

WP2, WP3 and WP4 will provide data for dissemination and exploitation of the project results, which is the subject of WP5. WP1 is related to all other Work Packages, being the management work package. The detailed description of each Work Package is given in the tables below and the list of all Work Packages of the BATEAU project are listed in Table 1.

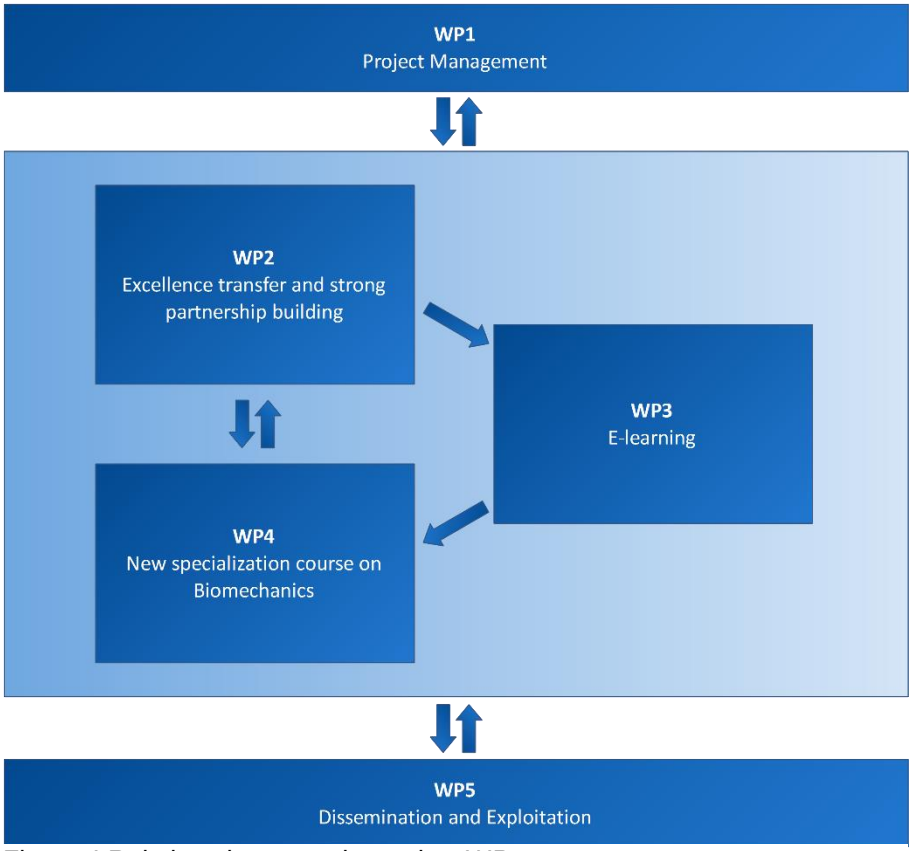


Figure 4 Relations between the project WPs

Work Package Description

WP1 Project management				
Participant no.	**1**	**2**	**3**	**4**
Participant name	**PUT - leader**	**UL**	**M&MOCS**	**TUDO**
Person/months per participant	**20**	**1**	**1**	**1**
Objectives				
– To plan and coordinate the work in the project. – To monitor progress in the project on an on-going basis. – To organize project meetings. – To ensure quality of the project results. – To ensure the project objectives are met. – To ensure effective communication between the consortium and the EC.				
Description of work				
Task 1.1. Project Management This task covers the overall management of the project. It will cover the organization of internal project meetings, the internal communication strategy and working environment to enable the objectives of the project to be completed. Each work package leader will manage their own work package and will carry out the tasks described here, while PUT will be responsible for the overall project management.				

Task 1.2. Administrative and financial management
This task encompasses all financial and administrative activities within the project, as well as maintaining the contact with the European Commission in all matters related to the project.
This work package will also include the evaluation of the project in terms of the progress towards project goals, as they have been set down in the present proposal.
Task 1.3. Risk Management
This task covers risk management of the project and will monitor progress for (potential) risk and initiate contingency plans to avoid risks or diminish their negative effects.
Task 1.4 Update of Participant Portal
PUT, as the coordinator from low performing institution in the Widening Country, will introduce in the reporting tool on the Participant Portal by month 2 of the project all PUT publications (in the field of research covered by the project) during the three years preceding the start date of the project. The deliverable related to this task (D1.2) will be a one-page statement that the task has been completed.

Deliverables

D1.2	Statement on the update of Participant Portal	M2
D1.1	Periodic report no. 1	M12
D1.2	Periodic report no. 2	M24
D1.3	Final Report	M36

WP2 Excellence transfer and strong partnership building				
Participant no.	**1**	**2**	**3**	**4**
Participant name	**PUT**	**UL**	**M&MOCS**	**TUDO - leader**
Person/months per participant	**10,45**	**5,2**	**9,7**	**5,2**

Objectives

- To transfer excellence from foreign universities to PUT to fill in the capacities gaps of PUT in the research area of solid body evolution and growth modelling.
- To cement the cooperation of PUT and its foreign partners and to build strong partnership around the research area of solid body evolution and growth modelling.

Description of work

The main idea of the project is to enhance the capabilities of PUT as an academic and research center in the area of a solid body evolution and growth modeling on both national and international levels. This aim is to be achieved mainly by arousing a rich flow of knowledge and experience from carefully selected prestigious European academic and research centers located outside Poland towards PUT. The flow will be transmitted via various channels, of which the most effective is based on the personal contacts and strong partnership. In each of the four tasks shortly described below, the personal contacts among the employees and students of PUT and their counterparts from the three partner universities play a crucial role.

Task 2.1. Staff and students exchange (UL)

The implementation of exchange visits will be updated and clearly presented before the kick-off of the project.

Experts from foreign universities come to PUT

A fruitful and comprehensive cooperation between PUT and each of the three partner universities within the project must be based on a common understanding of the challenges, needs, and barriers which are faced by the employees and students of PUT. For this reason, it is intended that researchers from the foreign universities will make visits to PUT. Also in this case, there is no restriction with respect to the position which a visitor occupies at his/her home institution, but it is likely that the visitors will be mostly advanced researchers (professors) – they are called here "experts", since the researchers will have thorough expertise in the domains covered by the project. The main idea standing behind such expert visits is to give the visitors a chance to meet and stimulate the cooperation with their Polish partners in the surrounding and environment where they fulfill their everyday scientific and teaching duties. This would let the foreign partners to work out their own unencumbered opinions about advantages and disadvantages of the Polish academic system. Only basing on such a knowledge the project beneficiaries can make joint and successful efforts to enhance the capabilities of PUT as an academic and research center.

The expert visits would be one of the crucial activities within the project and one of the main channels of the excellence transfer. The expert will give at PUT a series of lectures on the subject jointly agreed with the PUT representatives responsible for BATEAU. It is assumed that each expert visit will last **one week** and their total number is estimated to be **3 per year per each of the three foreign partner institutions, i.e. 27 visits within the project**. The expert visits are supposed to be distributed evenly throughout the project, which means that there will be 9 such stays within each of the three years of the project's duration. This means that there will be approximately 1 expert visit per month at PUT and these visits and the lectures (courses) given by the experts will give students a regular and important portion of knowledge. And they will at the same time cementing the cooperation of PUT and its foreign partners.

The visitors from the partner universities would be very welcome to participate also in various other activities at the hosting institution, for instance, by:

- presenting results of their own research at faculty seminars,
- delivering talks (or series of talks) for Ph.D. and advanced M.Sc. students,
- supporting researchers being at early stages of their academic careers,
- discussing with the Polish partners all issues relevant from the point of view of the research and teaching carried at the faculties of PUT as well as perspectives of further developments of the branches of science being of joint interest,
- elaborating with the Polish partners possible ways of acquiring funds for future joint research activities (grants, projects, fellowships, etc.).

Polish researchers go to foreign universities

It is intended that the researchers from the PUT team will visit the three foreign partner universities as well. The visitors can be from all levels of an academic career, i.e., professors, adjuncts (assistant professors), and assistants. The visits are to be aimed at tightening mutual cooperation between the four universities taking part in the project, by deepening bilateral contacts between the researchers working at these institutions. During the stays, the visitors from PUT are supposed to take an active part in the academic activities at the hosting university, for instance, by:

- participating in seminars (also presenting their own results),
- discussing with the foreign partners topics of joint interest and possible areas of further scientific investigations,
- making efforts to establish a sustainable net of European academic centers involved in the research and teaching in the area of the solid body evolution and growth modeling,
- taking advantage of all academic facilities provided by the hosting university (e.g., an access to library or labs),
- becoming acquainted with the academic systems applied abroad,

- becoming familiar with the programs of studies and solutions exploited with respect to the students' guidance.

It is assumed that each visit will last **one week** and their **total number is estimated to be 30**. The visits are supposed to be distributed evenly throughout the project, which means that there will be 10 such stays within each of the three years of the project's duration.

Polish students go to foreign universities

It is a truism to say that the future of various branches of research in, say, next 20 years, relies on the "quality" of students which just graduated or are about to graduate and are willing to follow academic careers. The same concerns the area of the solid body evolution and growth modeling. For this reason, a great deal of concern is devoted to ensuring that also the Ph.D. and advanced M.Sc. students from PUT take an extensive advantage of the project. One way to achieve this aim is to provide the students with a possibility to spend longer periods of time at the foreign partner universities, each of which is a reputable European academic center. It is believed that 2 weeks is a time long enough to give the students a chance to integrate with their counterparts at the hosting institution. In order to make the students' visits at the partner universities possibly beneficial, to following guiding roles are to be followed:

- each student will be assigned a tutor, who will be responsible for a student's stay at a given university;
- the student will have regular one-to-one consultations with the tutor;
- students will be, whenever possible, involved in the running projects, so that the knowledge and experience they gain is of practical value;
- the students will be allowed and encouraged to participate actively in selected lectures, classes, and seminars (provided the language is not a barrier) related to the topic of the project;
- the students will be provided with a possibility to present the results of their own research;
- the students will be provided with a possibility to interfere with local academia to take possibly extensive advantage (both academically and socially) of their stays.

It is assumed that each student visit will last **2 weeks** and their total number is estimated to be **45 within the project**. The student visits are supposed to be distributed (preferably) evenly throughout the project, which means that there will be 15 such visits within each of the three years of the project's duration.

Task 2.2 Thematic Workshops (TUDO)

Another important activity supporting both, the excellence transfer and strong partnership building is concerned with a participation of the beneficiaries of the project in Thematic Workshops. The Thematic Workshops may be organized by the project partners as stand-alone events or as separate sessions hosted within other conferences. Participation in both kinds of symposia has its advantages, which are shortly outlined below.

It is intended that 3 workshops, possibly once a year, will be organized by the project partners on the research subjects related to the research area covered by the project. It is believed that most (if not all) of the project partners will attend these meetings, and take advantage of the fact that the top experts in the area of the solid body evolution and growth modeling have gathered at one place.

Each internationally-leading partner will organize one Thematic Workshop, in the areas corresponding their expertise in the project, i.e.:

- Tissues – UL from France,
- Materials – M&MOCS from Italy,
- Optimization – TUDO from Germany.

Possible topics for the Tissues Workshop are: internal scale effects in bones from dedicated homogenization techniques; mechanics of generalized continua; phase field models for bone internal remodelling; biological aspects of bone remodelling; topology optimization; open systems thermodynamics as a framework to model living tissue evolution.

The thematic The Optimization Workshop is planned to cover some of the following topics: methods of non-linear programming; combination with non-linear Finite Element Method; application of non-linear programming to topology optimization and parameter identification; algorithms for non-linear problems including inequaltity constraints; evolutionary strategies toward structural design; optimization for multi-scale modelling including computational homogenization; application of biomechanics-related constitutive models to applications in structural design; Inverse Methods in Form-finding applications for elastic and inelastic solids.

The scope of the presentations will be by no means restricted to the project, and other talks dealing with topics of common interest will be warmly welcome. Furthermore, an extremely important part of the workshops will be played by (formal and informal) discussions among the project's partners. Thus, the organizers of each workshop will bear in mind that they should provide the participants with certain leeway enabling the attendees to spend some time with each other working on the topics and problems of joint interest. It is planned that some joint papers will be written based on the presentations and outcomes of the Thematic Workshops.

Locations of the subsequent workshops are not yet specified. They may be organized as stand-alone events or accompany some larger events and be the sessions within conferences having a scope of interest which covers (or is at least strongly related to) the topic of the project. Such sessions within larger events will additionally provide an excellent opportunity to disseminate the outcomes of the project among a wide audience of experts. Secondly, it will be much easier to invite external experts (not involved personally in the project) to take part, as speaker or participant, in the workshop and it is hoped that the external experts can provide a valuable input which will enrich the course of the project. Participating in such sessions can also give the participants from PUT an additional chance to present results of their own research and, thus, to shed light on the scientific capabilities of PUT.

Last but not least, it is worth mentioning that symposia of any kind are often the first occasions for young researchers at the beginning of their academic careers (i.e., assistants, Ph.D. or advanced M.Sc. students) to encounter more experienced scientists from outside of their home institutions, possibly from other countries. Such meetings may have a tremendous impact on their further careers, inspiring and influencing the choices they make, for instance, with respect to the topics they focus on.

Task 2.3 Summer Schools (UL)

Summer Schools are very popular these days and they are organized by many universities. The Summer Schools will gather PhD students and M.Sc. students from PUT. Each School will be organized around a specific research area in the fields of solid body evolution and growth modeling and its **aim will be to transfer the expertise and knowledge in these areas to PUT students**.

It is planned that the Schools will also be attended by student representing other than PUT project partner institutions, as this will be **an excellent opportunity for building relationships between students** that are one of the major goals in the BATEAU project. Good relationships are the key for a fruitful future cooperation between students in the fields of research.

The duration of one Summer School will be of 3-5 days and 3 such Schools will be organized, with ca. 20 participants at each School. Each School will be hosted by a different internationally-leading partner. The themes of each School will be related to the research areas corresponding to each partner's expertise in the project, i.e.:

- Tissues – UL from France,

- Materials – M&MOCS from Italy,
- Optimization – TUDO from Germany.

Possible topics for the Summer School on Tissues are: internal scale effects in bones from dedicated homogenization techniques; mechanics of generalized continua; phase field models for bone internal remodelling; biological aspects of bone remodelling; topology optimization; open systems thermodynamics as a framework to model living tissue evolution.

The Summer School on Optimization is planned to cover some of the following topics: methods of non-linear programming; combination with non-linear Finite Element Method; application of non-linear programming to topology optimization and parameter identification; algorithms for non-linear problems including inequality constraints; evolutionary strategies toward structural design; optimization for multi-scale modelling including computational homogenization; application of biomechanics-related constitutive models to applications in structural design; Inverse Methods in Form-finding applications for elastic and inelastic solids.

The Summer School concerning the Materials area will be focused around the concepts and models of new materials with unique features based on an optimal microstructure including metamaterials that could be developed and transferred to the field of biomedical engineering.

Task 2.4 Study Sessions (M&MOCS)

The Study Sessions will be organized in Poland for Ph.D. PUT students. Their **aim is to train Polish students to write good scientific papers**. An expert from M&MOCS will come to Poznan and will have practical lectures with a group of PUT students within which each of students will prepare a scientific paper in the area of solid body evolution and growth modeling. The expert will come three times, each time for a duration of one month, with 2-3 months interval. The students will start writing the papers during the first session and then will continue the work on them. They will then stay in the e-mail contact with the expert for additional guidance and with any questions they may have in relation to their work on the paper and will meet the expert in person at the two following sessions. The papers written within the Study Sessions will be submitted to some technical journals for publication.

All three sessions will be led by the same expert, assisted by a PhD researcher.

The study group will count ca. 10 students.

Deliverables		
D2.1	WP2 activities report 1 (containing information on the activities status, incl. basic facts and materials)	M12
D2.2	WP2 activities report 2 (containing information on the activities status, incl. basic facts and materials)	M24
D2.3	WP2 activities report 3 (containing information on the activities status, incl. basic facts and materials)	M36

WP3 E-learning				
Participant no.	**1**	**2**	**3**	**4**
Participant name	**PUT - leader**	**UL**	**M&MOCS**	**TUDO**
Person/months per participant	**5**	**5**	**5**	**5**
Objectives				
– To create an e-learning platform for BATEAU				

- To prepare e-learning materials
- To feed the e-learning platform with content
- To keep the e-learning platform up-to-date

Description of work

Task 3.1 Creating an e-learning platform for BATEAU (PUT)

E-learning means the application of information and communications technologies (ICTs), and in particular computers and the Internet, for teaching and learning. In order to enhance impacts of the project, a possibility of an online and computer-based learning will be provided to all beneficiaries of the project, with a particular attention paid to the Ph.D. and advanced M.Sc. students at PUT. The e-learning platform will be established and managed by an external service provider and it will be stored on the servers of the university. Care will be taken to choose the skilful and experienced service provider for this task. It is assumed that the platform will be created by the end of month 6 of the project and will be updated regularly throughout its duration (and possibly also afterwards). The platform is to be password-protected with an access restricted to the PUT team researchers and students, as well as to researchers and students from other partner institutions.

On the one hand, the content of the platform is to reflect regular activities carried out within the project, i.e., PowerPoint presentations, video recordings of lectures, and other related materials linked to the Thematic Workshops, Summer Schools, and Study Sessions mentioned in WP2, each of which is to be elaborated on purpose to satisfy requirements of an e-learning. On the other hand, it is assumed that some input will be created particularly for the needs of an e-learning process, e.g., contributions which would enable the students to verify their knowledge and progress in the knowledge accumulation (tests or quizzes).

Among the key advantages of an involvement of the e-learning platform in the project one can distinguish:

- the resulting repository of materials focused on the topic of the project, from rather basic (presentations at Summer Schools) to advanced (talks at Workshops),
- a motivation for the experts to prepare teaching materials (which otherwise would probably never be prepared),
- a reduction of time and costs related to the knowledge transfer (e.g., there is no need for a lecturer and students to meet at the same place at the same time),
- a possibility to adjust individually the speed and level of the learning process which suits each student,
- a possibility to return to certain parts of the material whenever desired.

The e-learning platform will give the opportunity for the students that were not able to take part in some activities of interest for them, such as e.g. Summer Schools, Thematic Workshops, to benefit from those activities in the time they find suitable. This will fortify the effect of these activities, being the excellence transfer tools in the project.

The thing to be highlighted here is that such materials repository will serve not only the students involved in TWINING but also the ones that will come to PUT in the next years, having – again – the beneficial multiplying effect of excellence transfer, as the beneficiaries here will be hundreds of students.

The ambitious goal within the project is also that the e-learning platform become the information exchange platform for both researchers and students. The need for this comes from real life, within the some joint initiatives undertaken by partners, e.g. when building a joint proposal (it appeared that the common database with information on different faculties, past and running projects, CVs of people, templates would be very useful for this purpose). The platform could also be used and have tools for joint projects preparation.

The project e-learning platform would be built based on an open-source tool (e.g. Moodle). As already mentioned, the platform will be developed and maintained by an external service provider (who will e.g. be feeding the platform with new content, granting access to users).

Task 3.2 Preparing materials and feeding the e-learning platform with content (PUT)

The e-learning platform will be fed with different materials – the ones related to the activities delivered within the project (presentations at Summer Schools, Workshops, lectures, courses prepared at this basis etc.) and the materials to stimulate the cooperation between the partners (as explained before).

The service provider that will develop and maintain the e-learning platform will also be responsible for preparing the materials he will be provided for e-learning purposes. He will also share his knowledge on how to prepare the e-learning materials with project beneficiaries, if required by them, e.g. via dedicated trainings. The experts producing the knowledge/courses within the project (professors/researchers from UL, M&MoCS, TUDO and also PUT) will be responsible for the preparation of the materials to be provided to the external service provider who will then turn them into attractive and effective e-learning materials.

E-learning is a wide concept and sometimes there are very poor realizations of e-learning courses. But the partners are motivated the e-learning platform to be developed within the project to become a living one and a source of excellent knowledge and that it is of a high quality, which is the standard in consortium partners internationally-leading institutions.

Apart from the materials strictly related to the area of solid body evolution and growth modeling, there will also be some other materials of interest for the BATEAU beneficiaries, e.g. on how to write scientific papers, how to apply for grants. It is also planned to put on the platform the guidelines and "how to" documents being the outcomes of the BATEAU project (also: best practices), such as e.g. how to plan and execute a staff exchange visit, how to organize workshops.

There will be three project deliverables that will be linked with the E-Learning platform. The platform building reports and the E-Learning Platform itself. The reports will contain the description of the platform functionalities and courses (materials) prepared within the project, and all the past and the future activities connected with the platform building.

Deliverables		
D3.1	E-Learning Platform building report	M18
D3.2	E-Learning Platform building final report	M24
D3.3	E-Learning Platform	M36

WP4 New specialization course on Biomechanics				
Participant no.	**1**	**2**	**3**	**4**
Participant name	**PUT**	**UL - leader**	**M&MOCS**	**TUDO**
Person/months per participant	**3**	**3**	**1**	**1**

Objectives

- To prepare the Biomechanics Specialization Course.
- To strengthen the researchers community in Poznan active in the area of solid body evolution and growth modelling and to promote the idea of concepts flow from biological and medical sciences to engineering and vice versa in this area.
- To strengthen the future research cooperation between partners in the fields of

Biomechanics.

Description of work

Task 4.1 Gathering of requirements

PUT is planning to build and open a new specialization on Biomechanics within the existing Faculty of Machines and Transportation. The biomechanics area is seen by PUT as having a great potential and a separate faculty of biomechanics will be opened, in time. To start a new faculty is time-consuming and requires an important administrative effort, in order all strict rules set by the Polish law and the PUT internal regulations are respected. Opening a new specialization within BATEAU will be the first step towards setting up the Faculty of Biomechanics.

It is now planned that the new course will count ca. 150 contact hours, and will last one year (2 semesters). It will be opened after the end of the BATEAU project. But specific requirements have to be gathered, as regards both the contents of the course and the organisational issues (how to well respond to all Poznan University of Technology procedures etc.). It has to be verified what would be the students interest in the new course etc. (it is now estimated to be very high, since lectures on the issues close to Bioechanics gather a great number of students). This is why the work on the course preparation will start in month 12. Since by that time the partners will have executed a number of joint activities (study visits etc.) and PUT would be able to better specify their needs for the course and also the partners will better know one another and their respective competences, which will foster the creative work on the new course and the synergy between the partners.

Task 4.2 Preparation of the course

As sais before, the Biomechanics specialization will concern the research area related to both biological and technical aspects. BATEAU gathering such excellent experts covering both of these aspects will be a perfect tool to prepare this specialization course and to plan the future collaboration on delivering it to students. Specifically, a detailed curriculum of the course will be prepared, as well as some basic materials needed to prepare didactical support for students. The team of the lecturers will be consolidated within the project and the lecturers will come from BATEAU partners institutions (the language for these lectures will be English) and it is planned that ca. 30% of courses will be provided by lecturers from outside PUT. In the first years and then this percentage will be decreasing, in line with the new possibilities of PUT in teaching (new competences acquired). Some of the lectures/courses given by the experts from internationally-leading institutions coming to Poznan for study visits will be edited and published as manuals for students. The course on Biomechanics will be opened after the end of the BATEAU project.

A Casebook will be prepared containing all the information and materials for the Biomechanics Specialization Course (including the detailed Course curriculum, description of lectures, description of work in laboratory, specification of the needed equipment, student manuals).

It has to be highlighted that some partners already have the experience of the similar work in creating a new course at master level (BioCad) – as described in section 3.3.

The research themes and areas that are planned to be covered by the new Specialization course are e.g.: computer-aided design of implantable medical devices, trabecular bone remodeling, structural optimization, systemic biology, terrestrial locomotion, locomotion in fluids, multibody simulation, computational fluid dynamics, head and neck biomechanics, engineering biomechanics, dental implantology, computed microtomography, bioimaging methods and techniques, anatomy, physiology, histology etc.

It is planned that the results of this WP will feed the proposal that will be submitted within the POWER programme, being one of the Operational Programmes for 2014-2020. POWER (Operational Programme Knowledge, Education and Development) will aim to improve the quality and efficiency of the Polish higher education system and is funded within the European Social Fund (ESF). The aim

of the proposal will be to create a Master degree course in Biomechanics (a special line in POWER is dedicated to such activities).

Deliverables		
D4.1	Biomechanics Specialization Course Casebook	M36

WP5 Dissemination and Exploitation (M1-M36)				
Participant no.	**1**	**2**	**3**	**4**
Participant name	**PUT**	**UL**	**M&MOCS – leader**	**TUDO**
Person/months per participant	**1,5**	**1,2**	**1,2**	**1,2**

Objectives

- To increase scientific visibility of PUT as a strong research center in the area of solid body evolution and growth modelling, both in Poland and in other European countries
- To familiarize a possibly wide audience of professionals with the project, its aims, activities, and outcomes.
- To take advantage of the knowledge, experience, and personal contacts acquired by the PUT employees during an execution of the project, in order to strengthen the research capabilities of PUT and to improve its competitive abilities in elicitation of grants and projects.

Description of work

Task 5.1. Dissemination of the project related information (M&MOCS)

The dissemination process will be composed of diverse activities which cover:

- Creation of the project's webpage which will provide up-to-date information on the project's aims, activities, current status, and outcomes. The webpage will be accessible to everybody, and not only to the project partners.
- Publication of scientific papers in reputable journals (also open access). It is assumed that around 15 scientific papers will originate from the activities carried out within the project. The reputable journals where the papers could be published are inter alia:
  - Archive of Applied Mechanics (impact factor 1.438),
  - Biomechanics and Modeling in Mechanobiology (impact factor 3.251),
  - Composite Structures (impact factor 3.120),
  - Computational Materials Science (impact factor 1.879),
  - International Journal of Engineering Science (impact factor 2.291),
  - International Journal of Plasticity (impact factor 5.971),
  - International Journal of Solids and Structures (impact factor 2.035).
- Participation in conferences, seminars, and workshops whose scopes of interests are related to the topic of the project. During the duration of the project (and afterwards), the project partners will take part in various scientific meetings (organized at national and international levels) and whenever possible they will present the papers which originated from the activities carried out within the project.
  Important events in the area of solid body evolution and growth modelling are inter alia:
  - Euromech (http://www.euromech.org/conferences),
  - Ictam (http://www.ictam2016.org/),
  - Wccm (http://www.wccm2016.org/),

- Solmech (http://www.solmech2016.ippt.pan.pl/),
- Cmm (www.pcm-cmm-2015.pg.gda.pl).

Task 5.2. Exploitation of the project outcomes (PUT)

It is clear that in general, a research center is as strong as its research team is. Hence, the main outcome of the project would be a scientific reinforcement of PUT by an enrichment of the capabilities of its employees with valuable knowledge and experience, as well as precious personal contacts. It is believed that the participation of PUT in the project will indeed strengthen the abilities of its employees (from professors, through Ph.D. researchers, to Ph.D. and advanced M.Sc. students), and, thus, improve the standings of the university among leading research centers within the area of solid body evolution and growth modelling. If this would be the case, several new possibilities, not available at present, would surely become accessible to the PUT employees. Among potential advantages of such a development one can list: (i) magnified interest of other scientists in the research carried out at PUT (resulting e.g., in bilateral visits of researchers from/at foreign universities, demand on talks and lectures delivered at research centers and meetings by the PUT employees, or invitations to carry out joint research or apply for joint projects), (ii) greater potential to acquire external funds for various activities (both from national and industrial entities), and (iii) enhanced interest in PUT by most ambitious students (to become). In other words, the project can be a cornerstone for an internationally distinguished research center within the area of solid body evolution and growth modelling established at PUT.

Deliverables		
D5.1	Dissemination and exploitation plan	M2
D5.2	Project internal and External Website	M2
D5.3	Dissemination and exploitation report	M18
D5.4	Dissemination and exploitation report	M36

Table 1 List of work packages

Work package No	Work Package Title	Lead Participant No	Lead Participant Short Name	Person-Months	Start Month	End month
1	Project Management	1	PUT	23	1	36
2	Excellence transfer and strong partnership building	4	TUDO	30,55	1	36
3	E-learning	1	PUT	20	3	36
4	New specialization course on Biomechanics	2	UL	8	12	36
5	Dissemination and Exploitation	3	M&MoCS	5,1	1	36
				Total months		

Table 2 List of Deliverables

Del. No	Deliverable name	WP no	Parti-cipant	Type	Dissemination level	Delivery date
D1.2	Statement on the update of Participant Portal	1	PUT	NA	CO	M02
D5.1	Dissemination and exploitation plan	5	M&MoCS	R	CO	M02
D5.2	Project internal and External Website	5	PUT	DEC	PU	M02
D1.1	Periodic report no. 1	1	PUT	NA	CO	M12
D2.1	WP2 activities report (containing information on the activities status, incl. basic facts and materials)	2	TUDO	R	CO	M12
D3.1	E-Learning Platform building report	3	PUT	R	CO	M18
D5.3	Dissemination and exploitation report	5	M&MoCS	R	CO	M18
D1.2	Periodic report no. 2	1	PUT	NA	CO	M24
D2.2	WP2 activities report (containing information on the activities status, incl. basic facts and materials)	2	TUDO	R	CO	M24
D1.3	Final Report	1	PUT	NA	CO	M36
D2.3	WP2 activities report (containing information on the activities status, incl. basic facts and materials)	2	TUDO	R	CO	M36
D3.2	E-Learning Platform building final report	3	PUT	R	CO	M36
D3.3	E-Learning Platform	3	PUT	OTHER	CO	M36
D4.1	Biomechanics Specialization Course Casebook	4	PUT	R	CO	M36
D5.4	Dissemination and exploitation report	5	M&MoCS	R	CO	M36

The Gantt chart for the BATEAU project is shown in Figure 5 below.

WP / number and name	Start	Finish	Quarters, number (overall: 3 years) 1 2 3 4 5 6 7 8 9 10 11 12
WP1: Project Management	**1**	**36**	
T1.1. Project Management	1	36	
T1.2. Administrative and financial management	1	36	
T1.3. Risk Management	1	36	
T1.4. Communication management	1	36	
D1.1. Statement on the update of Participant Portal			
D1.2. Periodic report no. 1			
D1.3. Periodic report no. 2			
D1.4. Final report			
WP2: Excellence transfer and strong partnership building	**1**	**36**	
T2.1. Staff and students exchange	2	36	
T2.2. Thematic Workshops	2	36	
T2.3. Summer Schools	2	36	
T2.4.Study Sessions	1	36	
D2.1. WP2 activities report no. 1			
D2.2. WP2 activities report no. 2			
D2.3. WP2 activities report no. 3			
WP3: E-learning platform	**4**	**36**	
T3.1 Creating an e-learning platform for BATEAU	4	6	
T3.2 Preparing materials and feeding the e-learning platform with content	4	36	
D3.1 E-Learning Platform building report			
D3.2. E-Learning Platform building final report			
D3.3. E-Learning Platform			
WP4: New specialization course on Biomechanics	**4**	**36**	
T4.1 Gathering of requirements	1	12	
T4.2 Preparation of the course	13	36	
D4.1. Biomechanics Specialization Course Casebook			
WP5: Dissemination and Exploitation	**1**	**36**	
Task 5.1. Dissemination of the project related information	2	36	
Task 5.2. Exploitation of the project outcomes	25	36	
D5.1 Dissemination and exploitation plan			
D5.2 Project internal and External Website			
D5.3 Dissemination and exploitation report			
D5.4 Dissemination and exploitation report			

milestones

Figure 5 Project's Gantt chart

3.2 Management structure and procedures

The management structure presented here is based on H2020 governance concepts developed by the DESCA ('DEvelopment of a Simplified Consortium Agreement for FP7') group. DESCA was initiated with the aim to create a framework that simplifies the process of reaching a consortium agreement for FP7 proposals. The DESCA frameworks have been updated to cater to the H2020 Programme. The BATEAU project borrows concepts from this framework for its management structure, and will use the standard DESCA model for the development of its Consortium Agreement. The management structure and procedures for BATEAU are appropriate to the complexity and scale of the project.

3.2.1 Management structure

The project management structure is shown in Figure 6. It is composed of: Coordinator, WP Leaders, All Partners, Quality Manager, Risk Manager, Dissemination and Exploitation Manager and the Project Board.

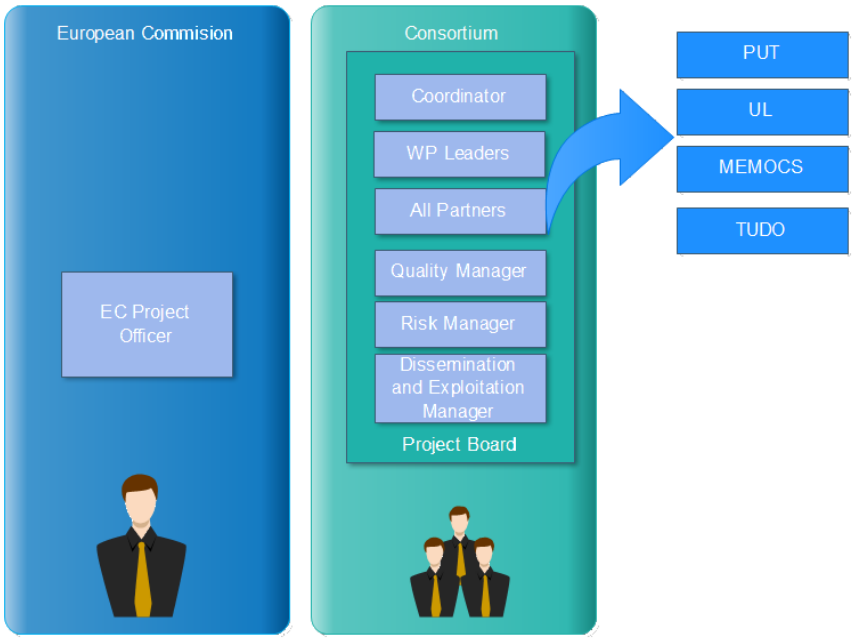


Figure 6 Governance structure of the BATEAU project

A Project Board will be assembled which will be responsible for the delivery of the project. This board will consist of one senior representative from each partner in the consortium, PUT, UL, M&MOCS and TUDO, that is authorised to make decisions on behalf of their organisation, thereby avoiding any unnecessary delays. Each board member will be given a single equal vote with the majority decision being carried. In the event of a conflict it has been decided that a vote consisting of three-fourths of votes will carry the decision and therefore steer the direction of the project towards project needs. In the event of a significant conflict resulting from a Board decision, a request for the issue to be escalated to the European Commission for advice and guidance will be made.

A project Coordinator and a Risk Manager will all be appointed from within the consortium to manage the various different aspects of the BATEAU project. The Project Coordinator will be responsible for the general administration and organisation of the project, which includes chairing official meetings and liaising with the European Commission. The Risk Manager will determine the various risks associated to the project and determine the appropriate mitigation strategies which are necessary to ensure that these risks do not inhibit the success of the project. The Quality Manager will be responsible for monitoring the quality of all project outputs and will ensure that all project materials meet the high standard which is expected of the consortium. The Dissemination and Exploitation Manager will be responsible for ensuring the publicity and commercial success of the project, under the guidance of Project Board.

3.2.2 Project Roles and Responsibilities

The BATEAU Project has a number of important aspects to monitor, contribute to and manage. As a result key areas of responsibility have been delegated to experts in the area, but all come under the single and final responsibility of the Project Coordinator.

These expert roles include:

Role	Person	Rationale
Project Coordinator	Prof. Michał Nowak,	Poznan University of Technology is highly experienced as a Project Coordinator.

	Poznan University of Technology	
Risk Manager	Kamil Sędłak, Poznan University of Technology	Project Manager with strong experience in FP7 projects, holding the Prince2 Foundation Certificate and PMP certification in progress.
Quality Manager	Jean-François Ganghoffer, Université de Lorraine	Jean-François Ganghoffer is one of the main driving forces for the BATEAU project and he has led at his home university a number of activities that are planned for BATEAU (Summer Schools, creating a course, staff exchange).
Dissemination and Exploitation Manager	Francesco dell'Isola, The International Research Center for Mathematics & Mechanics of Complex Systems (M&MoCS)	M&MoCS, and also professor Francesco dell'Isola himself, is very experienced in dissemination and exploitation matters.
Intellectual Property Rights Manager	Marek Morzyński Poznan University of Technology	With his strong experience in the European Projects in case of intellectual property rights Marek Morzyński will take great care to the project's products and protecting rights of their authors.

Project Board: The project Board will be empowered to ensure the overall success of the project and resolve any contractual issues within the consortium and for the European Commission (REA). The Board is responsible for overseeing the development of the project and reviewing its progress in accordance with each work package, milestone, objective and deadline.

Project Coordinator: Outside of the board meetings the project Coordinator is responsible for the general administration and running of the project. The coordinator will be responsible for:

- Organising and chairing Project Board meetings;
- Management of contractual, legal and financial information;
- Liaising with the European Commission;
- Collating all deliverables and milestones;
- General administration.

Risk Manager: The Risk Manager will be primarily responsible for defining, understanding and mitigating the risk environment associated with the delivery of the BATEAU project. This will involve the undertaking of a detailed risk assessment several times during the project. The Risk Manager must also undertake ongoing monitoring throughout the project duration of the identified risks and to identify the new risks which may be unforeseen during the early stages of the project, in order to apply proper mitigation measures.

Kamil Sędłak gained experience in administrating projects of the Seventh Framework Programme (FP7) at PUT: OPNEX 224218 (since 2008) and INDECT 218086 (since 2009). Since 2009 he has been holding the position of an administrative coordinator of INDECT 218086 (large collaborative research project, implemented in an international partnership under FP7) at the Department of Science of PUT. He received his B.S. degree in Computer Science from Poznan University of Technology (PUT) in 2010. Prince2 Foundation certificate obtained in March 2015. PMP certification in progress.

Quality Manager: The Quality Manager will oversee all activities undertaken as part of the BATEAU project in order to ensure that all members of the consortium adhere to the defined standards, and that the project outputs meet and exceed the required quality threshold.

Dissemination and Exploitation Manager: The role of the Dissemination and Exploitation Manager is to ensure the outputs of the BATEAU project are effectively disseminated to the defined audience, maximising the project exposure. In order to guarantee that the project results are effectively disseminated, the Dissemination and Exploitation Manager will be responsible to use appropriate dissemination channels and to coordinate the release of project information in an effective manner and on an ongoing basis.

Work Package Leader: Each work package has a clearly identified leader who has responsibility to coordinate the work within that work package, in close relationship with the Project Coordinator, setting detailed objectives for the work package. He/she is also responsible for monitoring progress and quality assurance (with the aid of the Quality Manager) of tasks within their work package. The Work package Leader is also responsible, through the Project Board, for inter-package liaison.

The day-to-day work carried out at each level (task or WP), needs some degree of freedom for each task leader and work package leader in order to facilitate effective decision-making, which will be properly coordinated with the Project Coordinator.

The management structure is designed to ensure that the project runs smoothly and that all goals are clearly defined and understood. To this end, responsibilities are clearly assigned, and Work Packages and Tasks represent a sensible division of the work and comprise the necessary expertise to fulfil the objectives, and there are clear lines of communication among the participants.

Project internal reporting and quality control procedures will be established defining the responsibility of the work package leaders in terms of deadlines, deliverables and correctness of the progress reports.

Intellectual Property Management

To avoid any eventual misappropriation and use of partners background information, it is necessary to conclude a non-disclosure agreement with the other partners before entering in to negotiations for the submission of the proposal. This agreement establishes the conditions under which partners disclose information in confidence, describe the procedures for the management and protection of intellectual property, which might arise from the project.

To avoid that this use (or re-use) of background leads to any breach of obligations or possibly an infringement of intellectual property rights belonging to others, all partners will identify the background needed for the project.

Patent searches in case of the product outputs has been performed by Espacenet, in national patent offices, PATLIB centers and private patent attorneys. In result none of the project background and planned effort does not violate property rights.

The consortium during the project will follow the rules and best practices with the help of approved handbooks and websites (e.g.. https://www.iprhelpdesk.eu/).

The roles of the IPR Manager will be to conduct the continuous effort assessment in case of the product and deliverables to ensure proper partners rights protection.

Individuals responsibilities allocation

Full of the allocation of key individual responsibilities will be updated and clarify before the project kick-off. Due the unknown amount of time between proposal submission and decision to start the project with financing, it is difficult to schedule all work and adapt the calendar of all engaged players.

3.2.3 Decision Making Mechanisms and Communication Strategy

The Project Board has the most senior decision making responsibility, where each member of the Board has 1 equal vote. Each level of management within the project will be able to take decisions accordingly with cooperative and agreement-seeking approach. If this fails the difference in opinion will be escalated to a more senior level. In the event of a contingency action not existing for a conflict or action which will render the project unable to complete a deliverable on time and to budget, the conflict will be presented and discussed within the next project Board Meeting.

Meetings can be organised through electronic communication means such as video, web or teleconferencing within agreed times and representation. This is the way of reducing costs, effort and making the work as effective as possible. There will be 4 personal meetings of the project consortium. The kick-off meeting will be organized at the beginning of the project. The other three meetings will be organized within the Summer Schools, since the Summer Schools will probably gather the most of partners representatives and since they will be organized in suitable time intervals (ca. once a year). The Project Board's meetings should take place at least once a year and/or in case it is the most suitable way to consult and proceed with project work and they will be organized at the occasion of personal meetings of the project consortium.

As for reporting, four formal reports are planned – three periodic project reports, established after each of the Summer Schools around which the project meetings will be organized. Periodic project reports will cover all activities and costs of project in the past period as well as the plan for the project activities for the next period. The fourth one, final report, will be established at the end of the project and will summarize all project's activities and costs incurred.

The Table 3 below contains the presentation of all project milestones.

Table 3 List of milestones

Milestone number	Milestone name	Related work package(s)	Estimated date	Means of verification
MS1	E-learning platform for BATEAU created	WP3	6	E-learning platform running
MS2	Requirements for the specialization course on Biomechanics gathered	WP4	12	Internal note describing the requirements
MS3	Summer School no 3 organized	WP2	22	D2.2. (WP2 activities report no. 2) delivered
MS4	Summer School no 4 organized	WP2	33	D2.3. (WP2 activities report no. 3) delivered

Risk management will primarily be the concern of the project risk manager. The risk manager will identify and monitor potential risks to BATEAU, and determine effective risk resolution strategies where necessary. The Risk Manager will report regularly to the Project Board outlining the risk environment for their consideration, and thereby allowing them to take necessary measures to mitigate the risk, under the advisement of the Risk Manager.

The Risk Manager will define the risk environment of the project based upon probability, and level of (negative) impact. Risks with a high probability and a severe impact will be handled with particular caution during the project. The following measures are foreseen to meet those risks:

1 The Risk Manager will undertake a risk assessment aimed at identifying potential risks and evaluating their impact and probability of occurrence.
2 For the risks with medium to high probability and severe impact, countermeasures and contingency plans will be decided and they will be handled very carefully throughout the project at Management, WP and Task level.
3 For risks defined as either low probability or low impact, the Risk Manager, in conjunction with the Project Board, will ensure that necessary countermeasures are taken and milestones concerning the evaluation for risk treatment needs are identified.
4 To deal with the risks that cannot be foreseen at the beginning of the project, the Risk Manager will undertake ongoing analysis of the risk environment.

The risks identified at the proposal writing stage, with the estimation of their probability and impact, as well as proposed risk-mitigation measures are included in the Table 4 below.

Table 4 Critical risks for implementation

Description of risk	WP(s) involved	Probability	Impact	Proposed risk-mitigation measures
Project delay and slow progress in general	WP1	Medium	High	Tight project management and full commitment to the project from WP leaders; application of management principles/tools/practices exploited in similar (successful) projects
Outflow of key personnel	WP1	Low	High	Prior specification of substitution or compensation policy by each partner
Abandonment of the project consortium by a partner institution	WP1	Low	High	In the unlikely scenario that a partner does not meet the consortium's performance expectations, and following reasonable attempts to rectify the situation, they will be removed from the consortium and replaced by a new partner. PUT has executed many EU project and has administrative services that will well

				advice on the legal aspects of this matter.
Difficulties with cooperation among the partners with respect to formal issues (e.g., difficulties with setting up satisfactory dates of staff and students exchange, thematic workshops, summer schools, or study sessions)	WP1, WP2	Low	High	Tight cooperation within the project based on mutual understanding of partners' needs and challenges; proactive search of approvable solutions based on understanding of relevant constraints
Substandard organization of the staff and students exchange as well as workshops, summer schools, and study sessions, which, thus, will not be too beneficial for the participants	WP1, WP2	Low	Medium	Tight proactive cooperation among the partners based on mutual understanding of needs and interests; setting up high standards and strong emphasis on the quality of all activities carried out within the project
Problems with quality and accessibility of inputs from partners (e.g., some of the partners may not be motivated enough to invest necessary efforts to timely prepare interesting lectures or take an active part in experts visits)	WP1, WP2, WP3	Low	High	Setting up high standards and strong emphasis on the quality of the inputs (constantly monitored by a multi-level internal quality monitoring chain)
Shortage of Ph.D. and advanced M.Sc. students interested in participation in the project's activities (e.g., in students' exchange, summer schools, study sessions)	WP2	Medium	Low	Proactive supervision of students and tailoring selected projects' activities to their needs and expectations; regular briefings with the students aimed at identifying their requests
Shortage or poor quality of materials to be included at the project's e-learning platform or its substandard functionality from the technical point of view	WP3	Low	Low	Constant monitoring of the quality and complementarity of the materials provided at the e-learning platform as well as its technical functionality; close cooperation with the partners having sound experience with e-learning and with the users of the platform
Difficulties with fulfilling formal requirements concerned with building a new specialization on	WP4	Medium	Low	Close cooperation with the authorities of the Faculty of Machines and

Biomechanics within the existing Faculty of Machines and Transportation				Transportation as well as the Rector of PUT aimed at identifying possible weaknesses and taking steps towards covering identified gaps
Difficulties with dissemination of the project related information (e.g., with publishing scientific papers, attracting attention of a wider audience to the project's web site, or participating in conferences, seminars, and workshops)	WP5	Medium	Low	Setting up high standards and strong emphasis on the quality of the dissemination materials (constantly monitored by a multi-level internal quality monitoring chain)

3.3 Consortium as a whole

Partners' excellence and complementarity

Consortium will consist of partners with complementary research and scientific potential. Partners from Germany, France and Italy are among the leading research centers in Europe.

There are only four partners in the consortium, as such a limited number makes it more probable that the partnership will prove to be more durable than in a network of many partners. One of the objectives of the project (Objective 7) is to build a sustainable network of institutions involved in the research in the solid body evolution and growth modeling and the consortium believes this is what will happen, even more that there already are strong personal links between the partners. It has to be highlighted that the Western Europe partners are perfectly aware of the aim of the project and that the focus is on Poznan University of Technology. It is clear for them that they are to transfer excellence to PUT, via different channels specified in the project and they have a motivation to do so.

The team of researchers from University of Lorraine that will be involved in the Twining project has excellent knowledge and expertise in the required panel of theoretical and numerical methods related to the core topics of the proposal, especially homogenization methods, mechanics of generalized continua, irreversible thermodynamics, multiphysical coupled problems, F.E. techniques for solving strong nonlinear problems. They have attained excellence in the field of Bone mechanics where these techniques have been recently applied to simulate bone internal and external remodeling at both microscopic, mesoscopic and macroscopic levels.

This is attested by the large scientific production in international Journals of high levels (J. Mech. Phys. Solids, J. Elasticity, Int. J. Solids Struct., JMBBM, J. Biomechanics, Int. J. Engng Sci., Int. J. Plasticity to mention but a few). In the last 5 years, the team of researchers from UL has published over 100 publications in International Journals with IF, and its members have been invited to deliver lectures in more than 20 international conferences. The existing collaboration with TU Dortmund University (J.F. Ganghoffer jointly organized two summer Schools with colleagues from TUDO under the umbrella of UFA, http://www.dfh-ufa.org/?id=1&L=1) and the collaboration with both PUT and Faculty of Civil Engineering at Warsaw University of Technology via two ERAMUS agreements have been strong driving forces to propose this Twining project. Both partners accordingly already know each other quite well and are used to mutual collaboration.

The researchers from M&MoCS involved in the Twinning project have excellent knowledge and wide experience in the required set of theoretical and numerical topics, in particular in variational and

homogenization methods, mechanics of generalized and microstructured continua, multiphysical coupled problems, F.E. and Isogeometric techniques for strongly nonlinear problems. They published very relevant results in Bone mechanics and Bone growth modeling, and developed models able to describe both natural growth and interaction between bones and synthetic prostheses.

This is attested by the prominent scientific production in international Journals of high level (among which: *Proceedings of the Royal Society of London*, *International Journal of Solids and Structures, Journal of Elasticity*, *Continuum Mechanics and Thermodynamics, International Journal of Nonlinear Mechanics, Journal of Vibration and Control*). In the last 5 years, the international team of researchers from M&MoCS has published over 150 publications in peer reviewed Journals with IF, and its members have been invited to deliver lectures in more than 30 international conferences. Finally, M&MoCS has wide experience in organizing conferences, workshops and Summer/Winter schools with international partners.

The participating team of researchers from TU Dortmund University holds a track record in the fields of continuum mechanics, modeling of materials, advanced numerical methods and optimization. This includes expertise in the modeling of biological tissues, continuum thermodynamics, variational methods, convexification, computational homogenization methods, development of advanced finite element formulations, algorithm for highly non-linear and coupled problems - such as diffusion problems and thermal, electrical and magnetic coupling - and topology optimization, structural design as well as inverse form finding. The researchers at TUDO have attained excellence in the research area of modeling and simulation of growth and remodeling of hard and soft biological tissues.

The expertise and excellence of the participating team of researchers at TUDO is documented by a large number publications in highly ranked international journals such as the Biomechanics and Modeling in Mechanobiology, Annals of Biomedical Engineering, Physics in Medicine and Biology, Computer Methods in Biomechanics and Biomedical Engineering, Structural and Multidisciplinary Optimization, Journal of the Mechanics and Physics of Solids, International Journal of Plasticity, Computer Methods in Applied Mechanics and Engineering, International Journal for Numerical Methods in Engineering, International Journal of Solids and Structures, Smart Materials and Structures, Journal of Intelligent Material Systems and Structures, amongst others. Within the last five years, the participating team of researchers from TUDO has published over 80 publications in international SCI-registered journals. The members of the team have been invited to give lectures at more than 30 international conferences. Three international PhD courses on Computational Continuum Biomechanics were given by one of the team members at the University of Zaragoza (Spain), Universidad Politecnica de Madrid (Spain) and Tampere University of Technology (Finland). The established collaboration with UL - F.-J. Barthold and J.-F. Ganghoffer jointly organized summer-schools on Evolutionary Solid Bodies, where several of the participants of this Twinning program gave lectures - is one of the driving forces for BATEAU.

The main areas of interest (research gaps) of **Poznan University of Technology** in the BATEAU project have been listed in section 1.3. It is expected that the excellence will flow from the Western Europe partners to PUT. Below the particular areas of expertise of partners have been listed.

The areas of excellence of **UL** in the context of the BATEAU project:

- Bone mechanics: computation of effective mechanical (static and dynamic) properties.
- Bone remodeling: multiscale models and numerical simulation tools.
- Shape and topology optimization for bone.
- Topology and shape optimization from a mathematical point of view.
- Homogenization techniques for network materials and lattice structures.
- Conception of bone biosubstitutes.
- Bioengineering (collaboration with biologists, medical doctors, surgeons).
- Tissue engineering.

- Symmetry analysis.

The areas of excellence of **M&MoCS** in the context of the BATEAU project:

- Bone mechanics: computation of effective mechanical (static and dynamic) properties.
- Modeling of bone formation and resorption.
- Modeling of bone interaction with natural/synthetic grafts.
- Constitutive modeling of materials with a microstructure.
- Metamaterials.
- Modeling of cellular dynamics in the bone formation/resorption processes.
- Non-linear phenomena in generalized beam theory.
- Damage detection methods via nonlinear behavior of harmonically forced response.
- Generalized continua.
- Micromorphic continua.
- Homogenization techniques.
- Piezoelectricity.
- Numerical methods based on refined versions of FEA.
- Non-linear Continuum Mechanics for Structures.
- Modeling and simulation of micro/nano mechanical systems.
- Theoretical modeling of general vibrating systems.

The areas of excellence of **TUDO** in the context of the BATEAU project:

- Background/contributions in the modelling of soft and hard materials (including remodelling, electrical coupling, etc).
- Model development - including Finite Element simulations in the fields of:
    - continuum-mechanics-based anisotropic growth and remodelling of bone
    - continuum-mechanics-based anisotropic growth remodelling of soft biological tissues (e.g. arteries)
    - response of bone under electrical stimuli/fields
    - activation and growth of muscles.
- Modeling of materials dedicated to biomedical engineering:
    - optimization of their shape, topology and microstructure.
    - inelastic fibre-reinforced materials (at large strains):
    - identification of optimal fibre orientations (one fibre family)
    - continuum models including bending stiffness (curvature) of fibres.
- Wound healing (diffusion-based model) - modelling and simulation of diffusion-based would healing in soft biological tissues.
- Phase-field based modeling of (tumor) growth.
- Phase-field-based topology optimization.

Figure 7 illustrates the different areas covered by the three advanced institutions, as indicated by the arrows. As a corollary, since a given area is covered by several advanced institutions, it also highlights the existing interactions between the three institutions, which will drive the improvement of PUT knowledge, know-how and capacities.

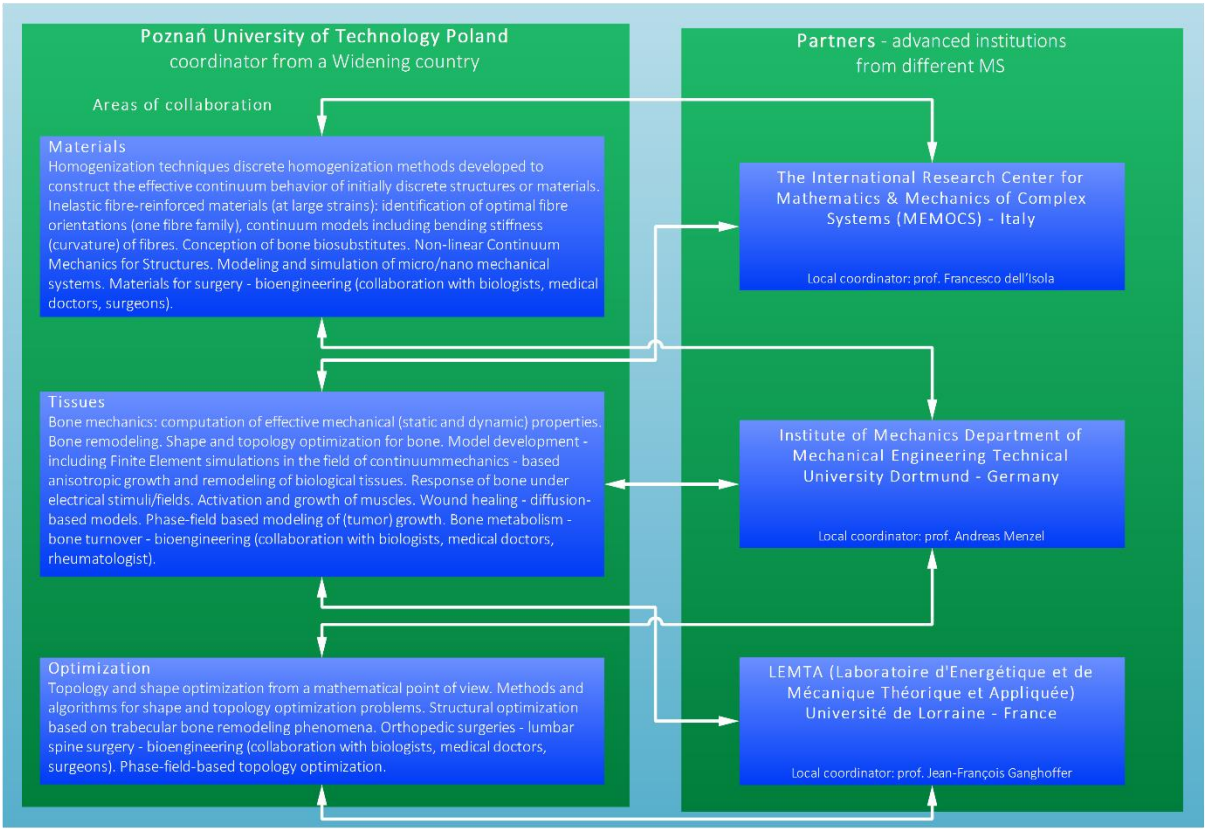


Figure 7 Partners' expertise complementarity in the BATEAU project

Partners previous cooperation

The approach adopted to achieve the best results within BATEAU is based on the cooperation up-to-date within the partner institutions and it intensifies what has already proved to be successful.

Joint organization of courses, such as international summer schools in the area of research covered by the project, has been established by the French and German groups of participants. Based on these successful collaborations, the research collaborations shall be established, further developed and strengthened. The participants organized joint events such as courses, workshops and conferences, as well as they had exchange and research visits of senior staff and Ph.D. students at the respective institutions of the participants.

One concrete and important example of partners previous cooperation is the experience some partners had of a joint work in creating a new course, called BioCAD. The creation of a new specialization course on Biomechanics within the existing Faculty of Machines and Transportation within the BATEAU project will benefit from the results of this work.

The BioCAD course was created as a common Initiative between the UL partner, Poznań University of Technology, Gdansk University of Technology (GUT, Poland), Gdansk Medical University (GUMed, Poland) and Bremen University (Germany, http://bionik.fbsm.hs-bremen.de/pages_EN/MSC_module.html), with the purpose to open in september 2018 a Master course with a low budget in order to be in position to apply to EU funding the next year (2019). The general topic of the BioCAD course at master level is computer-aided design of implantable medical devices. This course will be organized in the framework of the European collaboration in Biomechanics and Biomimetism. 1/3 of courses (100 hrs equally divided between Germany and Poland) will be provided by European partners, and 2/3 (200 hrs) by French lecturers:

- Germany: 50h Locomotion (Systemic Biology, Terrestrial Locomotion, Locomotion in Fluids, Multibody Simulation, Computational Fluid Dynamics, industrial product development).
- Poland: 50h Head and Neck Biomechanics, Engineering Biomechanics, Dental Implantology, Computed Microtomography, Bioimaging Methods and Techniques.

The French lecturers will deliver the following courses and lectures :
- Analysis of technical documents in English (ENIM),
- Anatomy, Histology,
- Reminders on the rigid body dynamics and Dynamic analysis of the human body in motion,
- Biomechanical characterization and modeling of biological tissues (ENSEM/ENIM/UL),
- Prosthetic device design and manufacturing,
- Numerical methods applied to biomedical applications,
- Design project,
- From mechano-transduction to rehabilitation,
- Transversal Project with assessment based on an oral presentation and written reports,
- Industrial seminars and visits (CERAH, OBL, Polyshape, Frohman…).

Another example of previous partners cooperation is the ERASMUS agreement signed in 2014 between Poznan University of Technology and the University of Lorraine and the renewed agreement between PUT and ENIM. UL also signed in 2011 the ERASMUS agreement with another Polish institution, i.e. the agreement between the Faculty of Civil Engineering in Warsaw and ENSEM (Nancy). It has been renewed for 2 years, and it will be regularly renewed. Ten students from ENSEM spend a one semester study at the Faculty of Civil Engineering in 2015.

Prof. Michal Nowak made a visit to give a seminar in LEMTA to present his activities on topology optimization and applications to bone external remodeling at the end of 2014. Prof. Jean-François Ganghoffer spent 4 days in Poznan in spring 2015 (May 04-08) in the framework of the ERASMUS mobility, during which he presented a panel of lectures to about 10 PhD students, devoted to micromechanics of bone and bone remodeling. It is planned in this ERAMUS mobility that prof. Michal Nowak and collaborators went to Nancy in fall 2015 to give similar lectures for a group of about 10 PhD students from both teams of Biomechanics in Nancy and Metz (independently from the work within the BATEAU project).

One important activity established between the project partners that will be the basis for the Summer Schools within BATEAU is the French-German Summer School on Solid Bodies Evolutionary Growth and remodeling of Biological Tissues that took place in Münster, Germany, in September 8-14, 2013. Prof. Michał Nowak took part in this School and had a lecture there.

3.4 Resources to be committed

Summary of staff effort

The Table 5 indicates the number of person/months over the whole duration of the planned work, for each work package, for each participant. The work-package leader is identified for each WP by showing the relevant person-month figure in bold.

Table 5 Summary of staff effort in the project

Partner	WP1	WP2	WP3	WP4	WP5	TOTAL PM
1.	**20**	10,45	**5**	3	1,5	39,95
2.	1	5,2	5	**3**	1,2	15,4

3.	1	9,7	5	1	**1,2**	17,9
4.	1	**5,2**	5	1	1,2	13,4
TOTAL PM	23	30,55	20	8	5,1	

Summary of total costs for each partner

The Table 6**Error! Reference source not found.** indicates the summary of total costs for each partner.

Table 6 Summary of total costs for each partner, in EUR

No.	Partner	Total Personnel	Total Other	Sub-Contracting	Indirect	Total Budget
1.	**PUT**	€ 99 875,00	€ 230 601,00		€ 82 619,00	€ 413 095,00
2.	**UL**	€ 100 100,00	€ 55 400,00		€ 38 875,00	€ 194 375,00
3.	**M&MoCS**	€ 105 610,00	€ 70 402,00		€ 44 003,00	€ 220 015,00
4.	**TUDO**	€ 80 400,00	€ 55 400,00		€ 33 950,00	€ 169 750,00
TOTAL						**€ 997 235,00**

"Other direct cost" items

The Table 7 shows the "other direct cost" items for each of the participants.

Table 7 "Oher direct cost" items in the project

Participant Number/Short Name	Cost (EUR)	Justification
PUT	45000	Staff exchange, 30 travels / 1500 EUR each
PUT	67500	Students exchange 45 travels / 1500 EUR each
PUT	4500	Thematic workshop organisation
PUT	4501	Project promotional materials
PUT	5000	New project proposal preparation (study course under Polish Structural Funds)
PUT	33000	15 conference attendance - inc. Travel and conferrence fee
PUT	6000	Website generation & Maintanence
PUT	15000	E-learning Platform establishing & config
PUT	22500	E-learning Technical material preparation
PUT	15000	E-learning Server for the platform
PUT	12600	Communication / Collaboration Platform
UL	13500	Expert Visits, 9 travel / 1500 EUR each
UL	4500	Thematic workshop organisation
UL	6500	Summer Schools organisation
UL	4500	Project promotional materials

UL	26400	12 conference attendance - inc. Travel and conferrence fee
MEMOCS	13500	Expert Visits, 9 travel / 1500 EUR each
MEMOCS	4502	Themathic workshop organisation
MEMOCS	6500	Summer Schools organisation
MEMOCS	4500	Project promotional materials
MEMOCS	26400	12 conference attendance - inc. Travel and conferrence fee
MEMOCS	15000	Study sesions for the Coordinator staff & students / travel cost 3 x 1 month stay
TUDO	13500	Expert Visits, 9 travel / 1500 EUR each
TUDO	4500	Themathic workshop organisation
TUDO	6500	Summer Schools organisation
TUDO	4500	Project promotional materials
TUDO	26400	12 conference attendance - inc. Travel and conferrence fee
	411803	

BATEAU

Excellence transfer to PUT in the solid body evolution and growth modeling research area based on the idea of concepts flow from biological and medical sciences to engineering and vice versa

Participant No	Participant organisation name	Participant short name	Country	Org. Type
1 (Coordinator)	Poznan University of Technology	PUT	Poland	University
2	Université de Lorraine - ESPE	UL	France	University
3	The International Research Center for Mathematics & Mechanics of Complex Systems (M&MoCS)	M&MoCS	Italy	University
4	TU Dortmund University	TUDO	Germany	University

Technical Annex Sections 4-5

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Project abstract:

The area of a solid body evolution and growth modeling focused recently a noticeable attention of scientists representing various research fields and notes a rapid progress. The staff of the Poznań University of Technology (PUT), in particular of the Faculties taking part in the project, has so far gained quite an experience in the research within the area of the solid body evolution and growth modeling. However, the potential of the university in the field is not yet fully utilized, for the university faces some capacities gaps and the BATEAU project will change this situation.

An enhancement of the research capabilities of PUT within the area of the solid body evolution and growth modeling and their applications is to be accomplished by establishing a cooperative network linking, besides PUT, also three other European research centers, namely: Université de Lorraine from France, The M&MoCS International Research Center from Italy, and Dortmund Technical University from Germany. There are several activities planned within BATEAU (such as staff and students exchange, thematic workshops, summer schools, study sessions) each of which is aimed at enabling and boosting an excellence transfer to PUT concerning concepts flow from biological and medical sciences to engineering and vice versa in the area of interest. The advantages of the project are to be beneficial not only for the employees of PUT, for an extensive concern is also devoted to allow the Ph.D. and advanced M.Sc. students from the university to make use of the knowledge, expertise, and experience which the foreign partners bring to BATEAU. Furthermore, besides scientific and educational aspects, an important role in the project is also played by objectives focusing on an enhancement of non-technical capacities of the staff of PUT. Additionally, a special attention is devoted to the dissemination of the projects outcomes. The project is perfectly in line with the TWINNING objectives.

4. Members of the consortium

4.1. Participants (applicants)

Poznan University of Technology (PUT)

Poznan University of Technology belongs to the top five technical universities in Poland. Located between Warsaw and Berlin, the University has many research and teaching contacts with European universities. It is the ten faculties, independent State University with over 90-year traditions. Actually, over 21,000 students are being educated here within undergraduate, postgraduate, doctorate, and continuing education programmes. PUT ICT Faculties have strong record in research and international cooperation. Among its projects were WINDFLEX, MASCOT (5th Programme Framework), WINNER I, WINNER II, URANUS, TANGO, NEWCOM, and Wireless Network of Excellence (6th Programme Framework). There exists formal international co-operation with Fraunhofer Heinrich-Hertz-Institut, Analog Devices, Mentor Graphics Corporation, and numerous Polish companies.

The PUT project team encompasses:

- more than 50 researchers, including 10 professors,
- 20 PhD students.

The PUT Faculties involved in the project are:

- Faculty of Machines and Transportation,
- Faculty of Civil Engineering.

Faculty of Machines and Transportation is represented by the Institute of Internal Combustion Engines and Transport. The Institute is divided into 3 chairs: Division of Internal Combustion Engines, Division of Rail Vehicles, Division of Virtual Engineering. About 60 researchers (15 professors and assistant professors, and 30 doctors) and 20 technicians are employed here. The group of researchers taking

part in the project has the required experience in executing the research projects for Polish industry, Polish government (system of research grants) and other universities and R&D Centers.

Faculty of Civil Engineering conducts research within the research grants and in the laboratories and it mainly covers the fields of:

- structural design methods in building technology,
- structural dynamics,
- structural fatigue,
- fracture mechanics,
- IT in civil engineering,
- geodetic and geotechnical problems in civil engineering,
- concrete, metal and wood construction and technology,
- air distribution and protection,
- temperature conditions in rooms,
- ventilation,
- hydraulic and hydrological problems in relation to environmental plants and projects,
- flow-mechanical problems in civil engineering structures.

Professor Michał Nowak, the leader of the BATEAU project, is the member of the Division of Virtual Engineering at the Faculty of Machines and Transport. The Division of Virtual Engineering provides expertise in Mechanics, Computational Fluid Dynamics, simulation, Finite Element Method. The Division has substantial experience in the flow eigenanalysis, including own methods and algorithms of solution of large generalized non-hermitian eigenvalue problems, modal analysis, flow empirical analysis (POD), flow modeling, modes interactions and low-dimensional models (LDM). This fundamental research serve better understanding of physics of fluids, as well as the feedback flow control. The research of this kind is closely related to the practical demands and serves for better understanding of phenomena like turbulence, coherent structures or transition. For example low dimensional analysis serves in rapid evaluation of large flow problems in aeroelasticity. The only one in Poland Flutter Laboratory is a common establishment of Institute of Aviation in Warsaw and PUT Division of Virtual Engineering. Division of Virtual Engineering is responsible for computational tasks while IoA deals with experiments and flight tests. The basis for our activity is the former EU-TAURUS project and scientific work of the group. 3D modeling and FEM computations of structural and CFD problems are based on in-house and commercial software. The second branch of Division of Virtual Engineering activity is represented by algorithm development, topological optimization and integration of existing codes and methods into the area of CFD and multidisciplinary problems like aeroelasticity (AE). The third kind of activity is parallel computations, hardware and software suitable for parallel computer clusters, MPI programming, domain decomposition on unstructured meshes and data exchange.

PUT Division of Virtual Engineering collaborates with universities in Germany, USA and France. Collaboration with TUB ISTA (former HFI) resulted in several common projects in the area of low-dimensional modeling and control of free and wall-bounded shear flows, global flow stability, AE, high performance CFD computations. Collaboration with UL concerns the growth modeling and topology optimization issues.

It should be said in this place that the specificity of the universities in Polish cities is such that there are several universities in a city, while in the Western European countries there would rather be one big university encompassing them all. But it has to be highlighted that the talks between the Poznan universities are in progress towards creating one big organism and such fusion is expected within a few years. The idea is supported by the Polish Ministry of Science and Higher Education.

Poznan has a 400 year old academic tradition. There are now 6 universities in Poznan: Poznan University of Technology, Adam Mickiewicz University in Poznan, University of Economy in Poznan, Medical University of Poznan, Poznan University of Life Sciences, Poznan University School of Physical Education. One big Poznan University would easily be ranked at so-called Shanghai list (Academic Ranking of World Top 500 Universities).

The rector of the Adam Mickiewicz University in Poznan, prof. Bronislaw Marciniak, said: "We will bring this idea (of universities merging) to life very slowly and systematically, that is by cooperating within the same projects, grants and research. Besides, this is what we have been doing for years now. Joint research areas are important". (http://epoznan.pl/news-news-41123-Poznanskie_uczelnie_polacza_sie_w_jeden_uniwersytet).

The mentioned cooperation within the same projects, grants and research is precisely what is happening for years now between the Poznan University of Technology, the Adam Mickiewicz University and the Poznan University of Medical Sciences in the research area covered by the BATEAU project. The most important activity here is the cooperation within the Centre of Excellence in Bionics. The Center of Excellence in Bionics is a Virtual Department at the Faculty of Machines and Transportation of the Poznan University of Technology and it joins the research on biology and on electronics. The Center of Excellence was created in 2013 with the basic objective to foster cutting-edge and crosscutting research, capacity building and technical knowledge base in the area of bionics. Bionics is a term which refers to the flow of concepts from biology to engineering and vice versa. The PUT Center of Excellence in Bionics addresses the application of biological methods and systems found in nature to the study and design of engineering systems and modern technology issues.

The mission of the Center is to foster strategic thinking by the principle that the essence of the entrepreneurial process of discovery is to support bottom-up activities and initiatives that will lead to smart growth and optimal utilization of resources, in particular those that will effectively engage the private sector in the operation and funding of research and innovation.

The activities carried out by the Center are in line with the European, Polish and regional Smart Specialization strategies:

- At the European Community level (linked with the Europe 2020 Strategy) it contributes to the EU Priorities :
  - Public health & security,
  - Public health & well-being,
- In scope of the national level, it contributes to the Polish national Smart Specializations:
  - HEALTHY SOCIETY: Medical engineering technologies, including biotechnologies and
  - INNOVATIVE TECHNOLOGIES AND INDUSTRIAL PROCESSES (HORIZONTAL APPROACH): Smart creative technologies.
- Greater Poland (Wielkopolska Voivodeship) Smart Specializations:
  - Development based on ICT especially in field of specialist ICT tools and products for the areas of expertise of the region,
  - Modern medical technologies supporting products, services and new technologies related to the prevention, diagnosis and therapy of civilization diseases and rare diseases and new methods of supporting diagnostic and therapeutic decisions using ICT and Big Data.
- Poznan University of Technology strategy of developing up to year 2020.

The center will provide support to the transfer of technology between lifeforms and manufactures which is, according to proponents of bionic technology, desirable because evolutionary pressure typically forces living organisms, including fauna and flora, to become highly optimized and efficient.

The Centre of Excellence is successfully cooperating with well-recognized and prestigious partners from academia and industry, such as:

- Rehasport Clinic, accredited as “FIFA Medical Centre of Excellence” The Rehasport Clinic team consists of orthopedists, radiologists, physicians, sports medicine doctors, rehabilitation physicians, surgeons, internists, physical therapists, but also the coaches of physical preparation, biomechanics, psychologists, nutritionists and sports managers. Rehasport Clinic provides the highest medical competence in the area of orthopedics, diagnostic imaging and rehabilitation. Rehasport Clinic specialists have, among others, taken care of members of the Polish Olympic team in Beijing and London. They are also members of the Medical Commission of the Polish Football Association,
- Poznan University of Medical Sciences – a leading medical school in Poland, currently recognized as the largest educational, research, and clinical center in Poland,
- Adam Mickiewicz University with Poland-leading experts of biological aspects of bionics, in particular in external stimuli evoked or communicated by robotic elements,
- Department of Structural Mechanics and Computer Aided Engineering of the Civil Engineering Faculty of the Warsaw University of Technology with its specialization on multi-material and free material design of structures as well as numerical methods of structural optimization.

The scientific cooperation between the PUT BATEAU project team is well established. The common research projects are carried out. The PhD students from different faculties work together in interdisciplinary teams. Also, researchers from other teams closely cooperating with the Poznan community declared a strong interest in strengthening the interdisciplinary research in the proposed area (i.e. a partner in the PUT Center of Excellence in Bionics, Warsaw University of Technology (Department of Structural Mechanics and Computer Aided Engineering of the Civil Engineering Faculty, with prof. Tomasz Lewinski at head).

Key Personnel:

Prof. Michał NOWAK (male) graduated in Mechanics in 1989 and in Mechanical Engineering and Management in 1991 from PUT. In 1997 he received a PhD degree, in 2007 he received the Doctor Ph.D.Hab. degree, both form PUT. He is employed as Associate Professor of Structural Mechanics at the Department of Virtual Engineering on PUT Faculty of Machines and Transportation. He is an author of over 120 publications in journals and conference proceedings published in Polish and English, mostly on biomechanics, structural optimization and multiphysics computations. His main research interests include: optimal design, topology optimization, aeroelasticity, biomechanics, finite element mesh generation and bionics. He acts as a reviewer for many high-ranked international journals, editor of Journal of Mechanical and Transport Engineering and member of the Editorial Board of AIMS Bioengineering journal. He is also leading author of Cosmoprojector, structural optimization system for aeroelastic analysis, developed within the FP5 Taurus, FP7 Idihom and Polish National Science Centre research projects. 91 papers, Impact Factor = 10,086., citations no.: 26 (Web of Science), H-index=3. In the papers when appears as the first author citations: 68, H-index=5, i10-index=1 according to the Google Scholar.

Prof. Marek MORZYŃSKI (male) graduated in Mechanics in 1976 and received a PhD degree in 1986 at Poznan University of Technology. His postdoc activity began in 1987 at Hermann Föttinger-Institut für Strömungsmechanik, Technische Universität Berlin and continued there till 1996. After returning to Poznan University of Techology and presenting his Habilitation in 1996 he become Assistant Professor at PUT and visiting Professor at Institute of Fluid Mechanics and Engineering Acoustics (ISTA), Technische Universität Berlin. Presently he is a Head of Virtual Engineering Department at PUT. Investigation in flow control, aeroelasticity, biomechanics, Finite Element Method, solutions of Navier-Stokes equations. He is the author of about 250 publications in the area stability, flow control, aeroelasticity, biomechanics, Finite Element Method, solutions of Navier-Stokes equations in high-ranked journals, some of them being citation classics. In his activity he lead several projects, both national, international and European, was organizer of conferences, referee of journals and participate in all forms of scientific activity.

Prof. Tomasz KOTWICKI (male), MD, PhD is an orthopedic surgeon and spine surgeon, Head of Spine Disorders Unit in the Department of Pediatric Orthopedics at the University of Medical Sciences in Poznan, Poland. In 1990 he graduated with distinction of the Poznan University of Medical Sciences (MD), in 1997 became specialist in orthopedics and traumatology (orthopedic surgeon), in 2000 obtained PhD degree, in 2014 became head of Spine Disorders Unit after receiving full professorship. Main interests: paediatric orthopaedic surgery, spine surgery, scoliosis non-operative treatment, basic research in orthopedics. Spine surgery equals 70% of total surgical activity. Important clinical activity in non-operative scoliosis treatment. Member of scientific societies: Society of Scoliosis Orthopedic and Rehabilitation Treatment SOSORT (President 2009/2010), International Research Society of Spinal Deformities IRSSD (Board Member 2006-2012), Polish Pediatric Orthopedic Society (Secretary 2004-2006), Polish Society of Spinal Surgery, Polish Traumatologic and Orthopaedic Society. Deputy Editor of Scoliosis Journal, Reviewer in international journals. Published 80 papers in PubMed/Medline indexed journals.

Prof. Tomasz ŁODYGOWSKI (male) is a professor of computational mechanics at the Institute of Structural Mechanics, Faculty of Civil and Environmental Engineering Poznan University of Technology. He was graduated in 1974. During his career he was awarded by Fulbright and Humboldt Foundations. He is the author and co-author of over 200 scientific papers, monographs, chapters in books and other important international presentations. Between 2002 and 2008 he was a vice-rector of PUT responsible for education. Recently he serves as a chairman of the Users' Council in Poznań Supercomputing and Networking Centre.

Prof Karol Miller (male) was born and educated in Poland. He received MSc in Applied Mechanics (1990) and PhD in Robotics (1994) from Warsaw University of Technology, and Doctorate of Science in Biomechanics from Polish Academy of Sciences (2003). In 2002 he established Intelligent Systems for Medicine Laboratory (ISML http://www.mech.uwa.edu.au/ISML) at The University of Western Australia. ISML's mission is to work towards improving clinical outcomes through appropriate use of technology. ISML runs exciting research projects generously funded by The Australian Research Council, National Health and Medical Research Council (Australia), National Institute of Health (USA) and other national and international agencies. The overall objective of Professor Miller's research is to help creating methods and tools which will enable a new exciting era of personalised medicine. Professor Miller is best known for his work on biomechanics of soft tissues. His current research interests include computational biomechanics for medicine and numerical methods, with applications to surgical simulation, image-guided surgery and, surprise, geomechanics. Professor Miller's research and teaching have been recognised by multiple awards, including Humboldt Research Award, NVIDIA GPU Computing Champion Award, Simulation Industry Association Australia Award, Sir Charles Julius Award, Polish Prime Minister Award, UWA Faculty of Engineering Computing and Mathematics Teaching Award and UWA Student Guild Choice Award.

Publications:

- Guzzomi, A., Male, S., Miller, K. 2017, 'Students' responses to authentic assessment designed to develop commitment to performing at their best', EUROPEAN JOURNAL OF ENGINEERING EDUCATION, 42, 3, pp. 219–240.
- Macrae, R., Pillow, J., Miller, K., Doyle, B. 2017, Constitutive Modelling of Lamb Aorta in Computational Biomechanics for Medicine: From Algorithms to Models and Applications, Springer International
- Kelsey, L., Schultz, C., Miller, K., Doyle, B. 2017, The Effects of Geometric Variation from OCT-derived 3D Reconstructions on Wall Shear Stress in a Patient-Specific Coronary Artery in Computational Biomechanics for Medicine: From Algorithms to Models and Applications, Springer International
- Joldes, G., Chowdhury, H., Wittek, A., Miller, K. 2017, 'A new method for essential boundary conditions imposition in explicit meshless methods', ENGINEERING ANALYSIS WITH BOUNDARY ELEMENTS, 80, pp. 94-104.

- Joldes, G., Miller, K., Wittek, A., Forsythe, R., Newby, D., Doyle, B. 2017, 'BioPARR: A software system for estimating the rupture potential index for abdominal aortic aneurysms', Scientific Reports, 7, 1, pp. 15.

MD, PhD. Tomasz Piontek (male) a graduate of the Poznan University of Medical Sciences. He had obtained his first degree of specialization in orthopedics and traumatology in 1999, four years later he passed the second degree of specialization, and in 2005 he defended his doctoral thesis. Tomasz Piontek is an international trainer of arthroscopic knee and hip surgical techniques.

Since 2006, Tomasz Piontek has been a doctor at Rehasport Clinic. Previously, he had worked, among others, in the Department of Paediatric Orthopaedics in Poznan, was the first football physician of Amica Wronki, and then served the same function in Lech Poznan. He had completed internships in Balgrist University Clinic in Zurich, Department of Orthopedics and Traumatology of Sports Medicine, Queens Medical Centre in the UK, and the University of Pittsburgh- Department of Orthopaedic Surgery, in the United States.

MD, PhD. Przemyslaw Lubiatowski (male) a graduate of the Poznań Academy of Medicine. He had obtained his first degree in orthopedics and traumatology in 1998, a year later he received his PhD, whereas in 2003, he had obtained a second degree of specialization. Przemyslaw Lubiatowski is a physician and director of the Non-Public Health Care Team in Rehasport Clinic, as well as the manager of the Department of Hand Surgery at the University of Medical Sciences, as well as an assistant professor of the Medical Cathedral, the Traumatology Clinic, Orthopaedics and Hand Surgery of the Medical University of Poznan. At the same time Przemyslaw is chairman of the Surgery of Shoulder and Elbow Unit of the Polish Society of Orthopaedics and Traumatology. He has completed internships at several medical centers in the United States (Clevlend, Pittsburg, Shepton Mallet Treatment Center and Rockford Orthopedic Associates) and in Edinburgh, Paris and Vienna.

MD, PhD. Kinga Ciemniewska-Gorzela (female) A graduate of the Poznan University of Medical Science, under the patronage of Karol Marcinkowski, where she had also defended her doctoral dissertation. King Ciemniewska – Gorzela is especially interested in minimally invasive operating techniques and anatomical drawing. She had been the medical leader during the III Division volleyball games; she worked in the Department of Orthopedics and Traumatology in Poznań and in NZOZ Orthomedica. She is a member of the Polish Society of Orthopaedics and Traumatology and the Polish Society of Foot and Ankle.

Dr Marcin WIERSZYCKI (male) is an assistant professor in the Institute of Structural Engineering at Poznan Univerity of Technology. He was graduated (MSc) in 2001 at Poznan Univerity of Technology. He received PhD in the field of numerical methods and modeling in biomechanics at Poznan University of Technology in 2007. He is a researcher with broad experience in many aspects of numerical simulation in solid, structural and fracture mechanics. He has deep knowledge of structural mechanics, mechanics of materials and computational mechanics. His scientific research is focused on dental implants, spine and bone modeling. He is the author and co-author of the many publications in journals, monographs and conference proceedings mostly in the field of biomechanics and numerical simulation.

Dr Malgorzata KOTWICKA (female), MD, PhD is the Head of Department of Cell Biology at the Poznan University of Medical Sciences (PUMS). In 1989 she graduated PUMS Medical Faculty (MD), in 1997 she obtained PhD degree, in 1998 became specialist in internal medicine. Elected for the 2012-2016 vice Dean post of the Health Science Faculty; 2012 University professor.

Main interests: cell biology, apoptosis, reproductive biology, basic research in orthopedics, endocrinology and gynecology. Member of scientific societies: Polish Society of Cytometry (chair of regional division), Polish Society of Cell Biology, Polish Society of Andrology, Section of Medical Sciences Polish Academy of Sciences (v-ce chair of regional commission). Reviewer in international journals. Published 40 papers (26 papers in PubMed/Medline indexed journals).

Piotr JANUSZ (male) M.D., Ph.D. graduated Faculty of Medicine in 2007 with honors of University of Medical Sciences, Poznan, Poland. In 2014 he received a PhD degree. He is employed as Resident at the Department of Pediatric Orthopedics and Traumatology of Poznan University. He is author of 9 publications in peer-reviewed journals and 19 abstracts and presentations at conferences in Polish and English, mostly on biomechanics, structural deformation of spine and genetic background of idiopathic scoliosis. His main research interests include: spine biomechanics, spine sagittal balance and etiology of idiopathic scoliosis. He acts as a reviewer for international journals such as Journal of Medical Genetics, Translational Research and Advances in Medical Sciences. He was co-investigator of Polish National Science Centre research projects.

Prof. dr hab. Przemysław Wojtaszek (male) is professor ordinarius for molecular plant cell biology at Adam Mickiewicz University. He is also a Deputy-Dean for Research and International Collaboration, and Head of Department of Molecular and Cellular Biology at the Faculty of Biology AMU. His main research focuses on the structural and functional integrity of plant cells, including the functioning of the cell wall-plasma membrane-cytoskeleton continuum as well as the role of protein complexes in the functioning of the endomembrane systems. He is also involved in studies on mechanical aspects of plant cell functions. Prof. Wojtaszek is an author and co-author of 111 publications in peer-reviewed journals, as chapters in the books, and more than 150 communications presented at conferences (Web of Science citations: 2037; h-index: 21). He was an editor of “Mechanical Integration of Plant Cells and Plants” (2011, Springer), and main co-editor of the Polish textbook on plant cell biology (2006-2007, PWN Warsaw, Poland).

Dr inż. Krzysztof SZAJEK (male) is employed as Assistant Professor of at the Department of Computer Aided Design on PUT Faculty of Civil and Environmental Engineering. The major fields of interest of the Author are biomechanics, optimization and computational mechanics. Great experience in use and designing of modern systems devoted to process integration and optimization. In 2005 graduated from Civil Engineering at PUT. In 2012 he received a PhD degree in the field of construction optimization (PhD thesis titled "Optimization of a two-component implantology system using genetic algorithm"). He is an author or co-author of over 25 publications in journals and conference proceedings published in Polish and English, including 3 monographs. Participated in 4 research projects in field of computer simulation mostly in biomechanics.

Prof. Tomasz Lewiński (male)

1.Homogenization of plates of periodic structure

2.Structural mechanics

3.Michell trusses

4.Free material design and its modifications towards : isotropic material design and cubic material design

1. Tomasz Lewiński , Józef Joachim Telega : Plates , Laminates and Shells. Asymptotic Analysis and Homogenization . World Scientific Publishing Co Pte Ltd; Series on Advances in Mathematics for Applied Sciences vol.52,str. 768 , 2000, Singapore, New Jersey, London, Hong Kong,
2. T.Lewiński, T.Sokół, On basic properties of Michell’s structures pp. 87-128. In: George.I.N.Rozvany, Tomasz Lewiński (Eds.) , Topology Optimization in Structural and Continuum Mechanics. CISM International Centre for Mechanical Sciences 549. Courses and Lectures. Springer Wien Heidelberg New York Dordrecht London, CISM, Udine 2014.
3. G.Dzierżanowski, T.Lewiński, Compliance minimization of two-material elastic structures. pp 175-212. In: George.I.N.Rozvany, Tomasz Lewiński (Eds.) , Topology Optimization in Structural and Continuum Mechanics. CISM International Centre for Mechanical Sciences 549. Courses and Lectures. Springer Wien Heidelberg New York Dordrecht London, CISM, Udine 2014.

4. S.Czarnecki, T.Lewiński, The Free material design in linear elasticity. pp 213-257. In: George.I.N.Rozvany, Tomasz Lewiński (Eds.) , Topology Optimization in Structural and Continuum Mechanics. CISM International Centre for Mechanical Sciences 549. Courses and Lectures. Springer Wien Heidelberg New York Dordrecht London, CISM, Udine 2014.
5. S. Czarnecki, T.Lewiński, A stress-based formulation of the free material design problem with the trace constraint and single loading condition. Bull.Polish Ac. Sciences. Tech.Sci. no 2., 60(2012) , pp.191-204.
6. T.Lewiński, G.I.N.Rozvany. T.Sokoł, K.Bołbotowski, Exact analytical solutions for some popular benchmark problems in topology optimization III: L-shaped domains revisited. Structural and Multidisciplinary Optimization, no 6, 47(2013) 937-942.
7. T.Lewiński, S.Czarnecki, G.Dzierżanowski, T.Sokół, Topology optimization in structural mechanics. Bull.Polish Ac. Sciences. Tech.Sci. no 1, 61(2013) pp. 23-37.
8. S.Czarnecki, T.Lewiński, On minimum compliance problems of thin elastic plates of varying thickness, Structural and Multidisciplinary Optimization, 48(2013) no 1, 17-31.
9. S. Czarnecki, T.Lewiński, A stress-based formulation of the free material design problem with the trace constraint and multiple load conditions. Structural and Multidisciplinary Optimization, 49(2014) no 5, 707-731.

Dr hab. Grzegorz Dzierżanowski (male)

1. Homogenization of plates of periodic structure

2. Topology optimization of solids and structures made of two or three isotropic materials. Relaxation by homogenization approach and the relevant numerical methods

3. Structural mechanics in general

Publications

1. Dzierżanowski G.: Optymalizacja rozmieszczenia materiałów w sprężystych płytach cienkich, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 2010.
2. Cherkaev A., Dzierżanowski G.: Three-phase plane composites of minimal elastic energy: High-porosity structures, Int. J. Solids Struct. 50(25-26), 2013, s. 4145-4160. Patrz również: http://arxiv.org/abs/1302.2729 (dostęp 13.12.2014).
3. Briggs N., Cherkaev A., Dzierżanowski G.: A note on optimal design of multiphase elastic structures, Struct. Multidisc. Optimiz. (w druku), DOI: 10.1007/s00158-014-1156-1 (dostęp 13.12.2014). Patrz również: http://arxiv.org/abs/1401.7652 (dostęp 13.12.2014).
4. G.Dzierżanowski, T.Lewiński, Compliance minimization of two-material elastic structures. pp 175-212. In: George.I.N.Rozvany, Tomasz Lewiński (Eds.) , Topology Optimization in Structural and Continuum Mechanics. CISM International Centre for Mechanical Sciences 549. Courses and Lectures. Springer Wien Heidelberg New York Dordrecht London, CISM, Udine 2014.
5. T.Lewiński, S.Czarnecki, G.Dzierżanowski, T.Sokół, Topology optimization in structural mechanics. Bull.Polish Ac. Sciences. Tech.Sci. no 1, 61(2013) pp. 23-37.
6. Grzegorz Dzierżanowski , On the comparison of material interpolation schemes and optimal composite properties in plane shape optimization
7. Structural and Multidisciplinary Optimization, vol. 46(5), pp 693-710, 2012

Dr Sławomir Czarnecki (male)

1. Numerical methods of the free material design and its modifications: isotropic material design and cubic material design

2. Numerical methods of truss optimization: merging shape and topology optimization

3. Pareto optimization

4. Finite element method in nonlinear mechanics

Publications

1. S. Czarnecki, “Application of the Strongin-Sergeyev global optimization method in the compliance minimization of latticed shells”, Comp. Assist. Mech. Engrg. Sci. 16(3/4), 291-307 (2009).
2. S.Czarnecki, T.Lewiński, The Free material design in linear elasticity. pp 213-257. In: George.I.N.Rozvany, Tomasz Lewiński (Eds.) , Topology Optimization in Structural and Continuum Mechanics. CISM International Centre for Mechanical Sciences 549. Courses and Lectures. Springer Wien Heidelberg New York Dordrecht London, CISM, Udine 2014.
3. S. Czarnecki, T.Lewiński, A stress-based formulation of the free material design problem with the trace constraint and single loading condition. Bull.Polish Ac. Sciences. Tech.Sci. no 2., 60(2012) , pp.191-204.
4. T.Lewiński, S.Czarnecki, G.Dzierżanowski, T.Sokół, Topology optimization in structural mechanics. Bull.Polish Ac. Sciences. Tech.Sci. no 1, 61(2013) pp. 23-37.
5. S.Czarnecki, T.Lewiński, On minimum compliance problems of thin elastic plates of varying thickness, Structural and Multidisciplinary Optimization, 48(2013) no 1, 17-31.
6. S. Czarnecki, T.Lewiński, A stress-based formulation of the free material design problem with the trace constraint and multiple load conditions. Structural and Multidisciplinary Optimization, 49(2014) no 5, 707-731.

Dr Tomasz Łukasiak (male)

The domains of activity:

1. Numerical methods of solving the basic cell problem of the homogenization theory for finding the auxiliary fields defining the effective moduli of the composite

2. Numerical methods aimed at solving the inverse homogenization problem:

Construct the layouts of two or three isotropic materials within a representative volume element (RVE) corresponding to given effective moduli. In the most important case one material is a void, which means that the problem refers to a porous solid or to a two-component composite with voids.

The numerical methods include mesh adaptation to minimize the FEM errors due to high contrasts between the moduli.

Publications

1. Łukasiak T., „Minimalizacja podatności tarcz dwu-materiałowych z obciążeniom wieloparametrowym. , XIX Polish-Ukrainian-Lithuanian Conference on "Theoretical Foundations of Civil Engineering",pp. 147-155, 2011 Warsaw, Ed. By W. Szcześniak, OWPW, ISBN 978-83-7207-958-9
2. Łukasiak T., “Two-phase composites with prescribed Kelvin moduli. The inverse homogenization problem”, 19th International Conference On Computer Methods In Mechanics , CMM 2011, ed. Borkowski, Lewiński, Dzierżanowski, Warsaw, Poland 2011, p. 329-330, ISBN: 978-83-7207-943-5
3. Czarnecki S., Lewiński T, Łukasiak T., Free Material Optimum Design of Plates of Pre-Defined Kelvin Moduli. 9th World Congress on Structural and Multidisciplinary Optimization, WCSMO-9, 13-17 June, 2011, Shizuoka, Japan, Book of Abstract
4. Łukasiak T., „Recovery of two-phase microstructures of planar isotropic elastic composites” 10th World Congress on Structural and Multidisciplinary Optimization, Optimization, WCSMO-10, May 19 -24, 2013, Orlando, Florida, USA, http://www2.mae.ufl.edu/mdo/Papers/5367.pdf, http://www.issmo.net/wcsmo10/Papers/5367.pdf (10 pages)

5. Łukasiak T., "Wyznaczanie efektywnych parametrów konstytutywnych kompozytów periodycznych za pomocą system Ansys", XXI Polish-Ukrainian-Lithuanian Conference on "Theoretical Foundations of Civil Engineering" Polish-Ukrainian Transactions, pp. 115-122 , Sept. 2013 Warsaw, Ed. By W. Szcześniak, OWPW, ISBN 978-83-7814-091-7
6. Łukasiak T., "Numerical homogenization of materials with periodic microstructure – computation of effective elastic moduli.", Mechanics and materials ed. S Jemioło, M Lutomirska, Warsaw University of Technology, pp. 77-86 OWPW 2013, ISBN 978-83-7814-170-9
7. Łukasiak T., "Two-phase isotropic composites with prescribed bulk and shear moduli" in Recent Advances in Computational Mechanics – Łodygowski, Rakowski & Litewka (Eds) pp. 213-222, 2014 Taylor & Francis Group, London, ISBN 976-1-138-02482-3
8. Łukasiak T., „Izotropowe kompozyty periodyczne – homogenizacja struktur I rzędu.", XXII Polish-Ukrainian-Lithuanian Conference on "Theoretical Foundations of Civil Engineering" Polish-Ukrainian Transactions, pp. 77-84 , Dec. 2014 Warsaw, Ed. By W. Szcześniak, OWPW, ISBN 978-83-7814-091-7

Tomasz Sokół

1. Numerical methods of solving the Michell layout problems in its original version (plastic design). The interior point method is used for solving the simplex problem of minimizing the weight of trusses of high number of possible bars (up to 10^12)
2. Optimum weight design of elastic trusses of huge number of possible bars.
3. Extensions towards multiple load cases
4. Stability of thin-walled bars and bar structures. Equilibrium paths.

Publications

1. Sokół T., Lewiński T.: On the solution of the three forces problem and its application in optimal designing of a class of symmetric plane frameworks of least weight, Structural and Multidisciplinary Optimization 42(6):835–853, 2010.
2. Sokół T.: A 99 line code for discretized Michell truss optimization written in Mathematica, Structural and Multidisciplinary Optimization 43(2):181–190, 2011.
3. Sokół T, Lewiński T.: Optimal design of a class of symmetric plane frameworks of least weight, Structural and Multidisciplinary Optimization 44(5):729-734, 2011.
4. Rozvany G.I.N., Sokół T.: Exact truss topology optimization: allowance for support costs and different permissible stresses in tension and compression—extensions of a classical solution by Michell, Structural and Multidisciplinary Optimization 45(3):367–376, 2012.
5. Sokół T., Rozvany G.I.N.: New analytical benchmarks for topology optimization and their implications. Part I: bi-symmetric trusses with two point loads between supports, Structural and Multidisciplinary Optimization 46(4):477–486, 2012.
6. Rozvany G.I.N., Sokół T. and V. Pomezanski: Fundamentals of exact multi-load topology optimization – stress-based least-volume trusses (generalized Michell structures) – Part I: Plastic design. Structural and Multidisciplinary Optimization, 50(6), pp. 1051-1078, 2014.

Selected relevant publications:

- 2017, Nowak, Michal and Sokolowski, Jan and Zochowski, Antoni, Justification of a certain algorithm for shape optimization in 3D elasticity
- Wierszycki M., Szajek K., Łodygowski T., Nowak M., A two-scale approach for trabecular bone microstructure modeling based on computational homogenization procedure, Comput Mech DOI 10.1007/s00466-014-0984-6, 2014, IF=2.432
- Hausa H., Nowak M., Parallel Mesh Generator for Biomechanical Purpose, J. Theor. Appl. Mech., 52, 1, pp. 71-80, 2014, IF=0.452

- Nowak M., From the Idea of Bone Remodelling Simulation to Parallel Structural Optimization, Numerical Methods for Differential Equations, Optimization, and Technological Problems, Series: Computational Methods in Applied Sciences, Springer, Vol. 27, pp. 335-346, 2013
- Nowak M., Improved aeroelastic design through structural optimization, BULLETIN OF THE POLISH ACADEMY OF SCIENCES-TECHNICAL SCIENCES 60 (2): 237-240, 2012, IF=0.980
- Nowak M., ON SOME PROPERTIES OF BONE FUNCTIONAL ADAPTATION PHENOMENON USEFUL IN MECHANICAL DESIGN, Acta of Bioengineering and Biomechanics, Vol. 12, No.2, pp. 49-54 , ISSN: 1509-409X, 2010, liczba cytowań=4, IF=0.333
- Estrogen receptor 2 gene polymorphism in idiopathic scoliosis.
  Kotwicki T, Janusz P, Andrusiewicz M, Chmielewska M, Kotwicka M.
  Spine (Phila Pa 1976). 2014 Dec 15;39(26):E1599-607. doi: 10.1097/BRS.0000000000000643.
- Optimal management of idiopathic scoliosis in adolescence.
  Kotwicki T, Chowanska J, Kinel E, Czaprowski D, Tomaszewski M, Janusz P.
  Adolesc Health Med Ther. 2013 Jul 23;4:59-73. doi: 10.2147/AHMT.S32088. eCollection 2013. Review.
- Improved accuracy in Risser sign grading with lateral spinal radiography.
  Kotwicki T.
  Eur Spine J. 2008 Dec;17(12):1676-85. doi: 10.1007/s00586-008-0794-7. Epub 2008 Oct 23.
- Intravertebral deformation in idiopathic scoliosis: a transverse plane computer tomographic study.
  Kotwicki T, Napiontek M.
  J Pediatr Orthop. 2008 Mar;28(2):225-9. doi: 10.1097/BPO.0b013e3181647c4a.
- Correction of flexible thoracic scoliosis below 65 degrees--a radiological comparison of anterior versus posterior segmental instrumentation applied to similar curves.
  Kotwicki T, Dubousset J, Padovani JP.
  Eur Spine J. 2006 Jun;15(6):972-81. Epub 2006 Apr 4.
- Kotwicka M, Filipiak K, Jedrzejczak P, Warchol JB. Caspase-3 activation and phosphatidylserine membrane translocation in human spermatozoa: is there a relationship? Reprod Biomed Online. 2008 May;16(5):657-63.

Selected relevant previous projects or activities:

1. Project - EU FP7- AAT- 2010- RTD-1, IDIHOM: Industrialisation Method of Higherr Order Methods, 2010-2014, Poznan University of Technology.
2. Project – NCN – 2011-2014 New method of physical modes generation for low-dimentional flows modeling, Poznan University of Technology.
3. Project – NCN – 2011-2014 Multidisciplinary modeling of aeroelasticity with structural optimization, Poznan University of Technology.
4. Project UDA-POIG.01.03.01-00-160/08-00, Development of a fast estimation method of the aeroelasticity of an airplane during the flatter parameters when in the air, 2009-2011, Poznan University of Technology and Institute of Aviation in Warsaw.
5. N N518 496039, Numerical analysis of 3D objects geometrical features in the aspect of 3D transcription of anthropometric and biometric data, 2010-2012, Poznan University of Technology.

Significant infrastructure and/or major items of technical equipment:

Virtual Engineering Department has the following laboratories:

1. Laboratory of Parallel Calculation - equipped with a 100-processor cluster connected by a fast fiber-optic network in Infiniband technology.
2. Virtual Engineering Laboratory, equipped with Rapid Prototyping machines, CNC machines, three-dimensional laser scanners and pin lasers. Printing is possible by using so-diversity of technologies and experience of the team and allows for the selection of a suitable method for creating 3D models of different objects.

3. The computer laboratory equipped with 16 workstations DELL 790c used in research and study equipped with software such as CATIA V5 R19, SolidWorks, SolidCAM, FEMAP, Geomagic, rhinoceros, Windows, Office, NEiNastran, MDNastran, Marc, CentaurSoft, Ansys ICEM CFD, 3DTransition and VMware.

Université de Lorraine (UL)

With more than 3,700 teaching and research faculty and approximately 53,000 students, including nearly 7,000 foreign students, the Université de Lorraine (UL) is one of France's largest multidisciplinary universities. Its location in the heart of Europe, with borders on three European member states (Germany, Belgium and Luxembourg) offers to UL a privileged position for strong international partnerships. In particular, the Université de Lorraine is a member of the cross-border university network of the international region associating Lorraine, Saarland, Rhineland-Palatinate, Luxembourg and Wallonia, and involving 7 major universities. The cross-border network takes advantage of the proximity of several foreign universities to encourage and facilitate the mobility of the university community, network researchers and increase the influence of the region in Europe.

On a larger scale, UL is committed to numerous European and international collaborations and exchanges, including multi-partnership projects and initiatives that, in many cases, go beyond European borders. More specifically, UL has demonstrated its experience not only in participation but also in coordination of several large-scale European projects : SECUREAU (FP 7), IMPULSE (FP 6)… The IMPULSE project (FP 6) was distinguished in 2012 as " Best project in industrial technologies of FP 5, FP 6 and FP 7".

Strong scientific expertise

The scientific activity of the Université de Lorraine is organized in 82 research laboratories located in 10 scientific centers and 8 research federations covering a wide range of disciplinary fields and topics: agriculture, food science, forestry, environment, energy, biology, medicine, health, chemistry, physics, process engineering, product engineering, materials science and engineering, metallurgy, mechanical engineering, computer science, automation, electronics, mathematics, communication, social sciences, literature, languages, law, political science, economics, management , arts, architecture...
In addition, the university houses several technology platforms including large-scale facilities and large measurement instruments, providing research teams with the most efficient equipment.

A complete range of educational opportunities

From an educational point of view, the Université de Lorraine is structured in 8 Collegiums, which include the various schools, faculties, institutes. The educational opportunities cover initial training in all fields of the knowledge, with cross-cutting programmes between institutions and between disciplines, allowing students to adapt their studies to their personal development needs. UL is also a major player in life-long learning in France, with more than 1500 degrees granted.
Its current student population is 55,000, the majority being in Nancy, and about 10.000 on the campuses in Metz. This represents almost one student for seven inhabitants. Some 6,000 international students study on various campuses in Nancy, a city with a strong university tradition. The university is divided into two university centers, one in Nancy (biological sciences, health care, administration and management) and one in Metz (material sciences, technology, and management). To mention a few figures, the University of Lorraine has about 55,000 students and offers 101 accredited research centers organized in 9 research areas and 8 doctoral colleges. University of Lorraine counts over 7500 foreign students representing 138 nationalities (15% of the overall student population), and 25% of them from the European Union. There are 837 outgoing Erasmus students and 524 entering Erasmus students. The University welcomes yearly 580 international researchers through the Euraxess service centre, counts 5 international laboratories, and around 30% of scientific publications are jointly written with foreign researchers.

http://welcome.univ-lorraine.fr/sites/welcome.univ-lorraine.fr/files/users/images/factsinfigures-ul.pdf

Strong regional and territorial impact

The Université de Lorraine plays a major role in the socio-economic development of the Lorraine region and the country by creating an interface between the academic world on the one hand, and professional and industrial worlds on the other. This interface contributes to valuable and enriching exchange for all stakeholders through innovation, partnerships, knowledge sharing, research, development and technology transfer.

UL, through its own service for research exploitation, aims to create value from the research and expertise of its researchers. This development may take the form of research contracts, licensing, business creation or technology transfer and commercialization of intellectual property.

LEMTA (Laboratoire d'Energétique et de Mécanique Théorique et Appliquée) a joint research unit linked with CNRS (UMR CNRS 7563) and Université de Lorraine, focuses its research activity on mechanics and energy. LEMTA is one of the 5 laboratories of the 'Fédération Jacques Villermaux pour la Mécanique, l'Énergie et les Procédés', a large laboratory consortium with transdisciplinary competencies. The research activities are organized around Fluid Media, Energy and Transfers and Solid Mechanics. Hosting three research departments (Reacting, Multiphase Fluid Media, Mechanics of Materials and Structures, Energy and Transfers), the laboratory's research is centered around three main axis of excellence: measurement science in complex media, multi-physics/multiscale modeling and multiphase media. The activities are harmoniously and equally divided between basic research, social or environmental questions and applied research. Modelling of forest fires, fire-fighting, nuclear waste disposal, fuel cells, droplet combustion, the improvement of steel and glass manufacturing processes, bio-engineering and petroleum engineering are a few of the applications of the work derived from the research activities of LEMTA's 79 researchers, the same number of PhD and post doctoral students and 24 technical and administrative staff. These applications are made possible thanks to the development and use of sophisticated measurement techniques: for example, NMR, usually devoted to medical applications, for the visualization and quantitative analysis of flows in non transparent media, fluorescence based diagnosis, infrared thermography at high temperature and rheo-physics apparatus. The laboratory is fully committed to an international outlook and as such is involved in cooperation work with leading world laboratories and more particularly with European laboratories, all of which leads to the production of joint papers, work on European contracts and network building. LEMTA cooperates with many institutional partners, research centers and industrial partners and participates or coordinates several ANR (Agence Nationale de la Recherche, the French National Research Agency) research programs. It coordinates the joint CNRS and ONERA research program into experiments and simulation of multicomponent sprays and is involved in a joint laboratory with Institut National sur la Recherche et la Sécurité (National Research and Safety Institute). Our industrial partners include ARCELOR-MITTAL for the steel manufacturing processes development, our partnership with HELION and AIR LIQUIDE working on fuel cells, the development of measurement techniques in fluid flows with DANTEC DYNAMICS, collaborations with AIRBUS on the thermal management of aircraft engines, Daum or Baccarat for glass processing, Schlumberger and Total from the petroleum industry, and the car manufacturers Renault and Peugeot among others.

Group of Mechanics of Solids and Structures

The group is one the three research departments of LEMTA; its work and objectives are concentrated on the characterization of the mechanical behavior of materials and structures and also theoretical aspects related to their multi-scale and/or multi-physic modeling.

The main scientific fields of interest of the group are:

1- Multi-disciplinary, multi-scale (from statistical mechanics to homogenization), and/or multi-physical modeling of the behavior of nano-micro-(meso)-structured materials, whether they be crystalline or amorphous.

2- Thermomechanical characterization:

- measurements of mechanical and thermal fields
- in situ monitoring of microstructural evolution based on the physics of radiation-matter interactions
- complex loading paths
- dynamic behavior and dissipation
- interaction material/process during forming

3- The development of:

- innovative methods in numerical simulation,
- inverse and optimization methods,
- specific finite elements design, and the implementation of nonlinear constitutive laws in finite elements codes.

Staff

- 20 Researchers and academics
- 11 Doctoral students
- 4 Post-doctoral

Scientific Topics

- Behavior of materials with multiphysical couplings
- Behavior of structures in extreme conditions
- Behavior and dimensioning of adaptative structures
- Biomechanics of living materials and structures / bioengineering

Subjects of research work

- Bio-engineering of tendon tissues and cartilage
- Thermomechanics and rheology of polymer materials
- Non-elastic modelling in large deformations
- Thermomechanical behavior of thin films of shape memory alloys (non local approaches)
- Ferroelectric and ferroelastic behavior of thin piezoelectric films
- Product-Process-Material approach for the machining and numerical simulation of advanced forming processes

Industrial and societal applications

- Bio-mechanics / bio-engineering for health
  Mechanics of innovative materials (nano-structured polymers, adaptive materials, …)
- Machining and forming in large transformations (extreme conditions of temperature, velocity, …).

Not all the members of the group of Solids and Structures will be involved in the BATEAU project, but actually one subentity of it, the group of Biomechanics and Bioengineering in LEMTA – jointly with the group of Biomechanics at LaBPS, another Laboratory of the Université de Lorraine - regarding the following scientific topics:

- Biomechanics of bone: bone static and dynamic effective properties, internal and external remodeling.
- Specific homogenization techniques to determine the classical and non classical mechanical properties of bone (generalized continua).
- Multiphysical aspects in biomechanics, like coupling between mechanics and transport phenomena.
- Irreversible thermodynamics as a sound framework to write constitutive laws at different scales and to identify the driving forces for bone remodeling.
- Computational methods in Biomechanics.

- Transfer of knowledge, know-how and different experimental and numerical techniques to the Polish partners.

Nevertheless, all experimental and numerical resources of the group of mechanics of Solids and Structures will be available to the Polish partners.

Activities in Biomechanics at the Université de Lorraine

The activities of the two groups of biomechanics at Université de Lorraine (LEMTA and LaBPS) are balanced between the development of fundamental research and activities in bioengineering aiming at the conception, realization and testing of biomaterials such a bone and ligament biosubstitutes. Fundamental research is devoted to multiscale models of bones and ligaments, dedicated homogenization techniques for the prediction of the effective response of network materials like bone or biological membranes, accounting for size effects and large perturbations of the network geometry and configuration.

Description of the group of Biomechanics at LaBPS

Founded in 1973, the Laboratory of Reliability Mechanics became in 2008 the Laboratory of mechanics Biomechanics Polymer Structures (EA 4632, recognized by the ministry of Higher Education and Research). The scientific objective of the LaBPS is to study the various aspects (experimental, modeling, stimulation) of the mechanics of materials, structures and living tissues, at different levels (micro, meso and macro).

Since its creation, the laboratory has developed numerous research tools in the field of mesomechanics, applicable to problems of damage, breakage and structural fatigue. In 2003, important changes in the size, subject and structure of the laboratory lead to the creation of three teams:

- Dynamic behavior of materials and structures
- Adaptive behavior of biologic tissues
- New polymer based materials

Thematic areas of research

The LaBPS conducts research works of fundamental character, -+applied to industry problems. The laboratory intends to maintain the excellence of its scientific work and its anchorage in economy, in the areas of:

- Mechanics of materials and structures, (reliability, damage, breakage)
- Dynamic behavior of materials and structures (damage, breakage)
- Dynamic interactions (tribology, friction, vibration)
- Composite polymer-based materials, (eco-polymer, vegetable fibers)
- Behavior of leaving tissues (behavior of bone remodeling, prosthetic systems)

On January the 1st of 2015, the LaBPS regroups 22 Researchers, 1 research engineer, 4 technicians, 1 administrative staff and 15 PhD and post-doctoral students.

Team of Biomechanics and Bioengineering in LEMTA

Activities specifically devoted to bone mechanics in the broad sense include micromechanical schemes for predicting the effective static and dynamic homogenized properties of trabecular and cortical bone based on the geometry of bone architecture at the trabecular level, the development of a simulation platform for internal and external remodeling at both microscopic, mesoscopic and macroscopic levels, based on configuration mechanics. The scale effects due to the bone microstructure (trabeculae) are accounted for by enriched continuum models (second order gradient, micropolar models), reflecting the microstructural topology and properties of the underlying trabecular microstructure. Two PhD students recently defended their thesis on these topics, and one PhD thesis

started in early 2014 to model and simulate the effect of vibration on the remodelling of arteries, in the context of a collaboration with INRS (Institut National de Recherche sur la Sécurité in Nancy).

The team recently started research activities on phase field models for bone, in collaboration with the Centre des Matériaux in Ecole des Mines de Paris (S. Forest, who has a strong expertise in phase field models and simulations).

Activities in tissue engineering started in early 2011 and aim at the conception, modelling and fabrication of biosusbstitutes for ligaments; two permanent staff from the team of Biomechanics and Bioengineering of LEMTA are active on this topic.

Research carried out in the field of anatomic and functional rehabilitation combine the results provided by the fundamental studies on bone behaviour with mechanical analyses (structural dimensioning, motion analysis…) to design new prosthetic solutions and/or bone substitutes.

Group of Adaptive Behavior of Biological Tissues in LaBPS

The research activities of this group focus on dental biomechanics and cranio-maxillofacial surgery. Fundamental research work aims to describe the instantaneous and evolutionary behavior of biological tissues. In parallel, custom numerical models are developed to provide support to clinical decision and propose new anatomical and functional reconstruction solutions. New devices are designed in collaboration with health professionals and biomedical industry. Validation is performed by means of experimental tests. This global approach aims to contribute to the scientific breakthrough in the behavior of bone tissue and enable healthcare professionals to optimize and expand the arsenal of treatment options offered to patients.

Main scientific topics:

1. *Bone tissue behavior*

- Bone adaptive behavior

Healing and bone remodeling processes are analyzed through the development of micromechanical models taking into account the different volume fractions of new formed tissues. The main objective is to analyze the interactions between biological tissues and implantable medical devices.

- Instantaneous behavior of cancellous bone

The studies aim to determine the mechanical properties of the bone trabeculae through inverse methods from the measurement of apparent properties of cancellous bone. These works combine experiments and modeling (finite element simulations, homogenization methods).

2. *Anatomic and functional rehabilitation.*

- Treatment of edentulism by prostheses on implants

Numerical models of the prosthesis with implants and its environment are built to propose an optimization of existing prosthetic systems.

- Design and characterization of new reconstruction solutions for cranio- maxillofacial surgery

The work carried out aim to provide solutions for bone or multi-tissue defects filling (osteogenic distraction, porous titanium bone substitutes ...). The solutions are experimentally characterized and their functionality is evaluated through suitable numerical models.

- Design of custom prostheses for the temporomandibular joint (TMJ)

The TMJ behavior is studied through kinematic and dynamic analyzes. Experimental measurements of the jaw motions coupled with electromyography are carried out. Numerical models are developed to determine the mechanical fields inside the joint.

Both teams in Biomechanics have many international collaborations in Biomechanics and Bioengineering, including partners from: Algeria (mechanics of bone), Brasil (University of Sao Polo, cartilage Bioengineering, University of Campinas: dental prostheses), Bulgaria (Institute of Biophysics in Sofia on the mechanics of biomembranes), Canada (wave propagation in living tissues), Germany (optimization methods for biomechanical applications), Poland (Faculty of Civil Engineering, Warsaw: topology optimization for bone based on Free Material Design; AGH, Cracow: determination of the elastic properties of bone trabeculae), Russia (mathematical models for tissue growth, with P. Plotnikov), Switzerland (ETH, Zurich, group of E. Mazza on the mechanics of biomembranes and tendons / ligaments), Tunisia (higher order models for bone).

Both teams in Nancy and Metz are working together to set a common ERASMUS MUNDUS master program at European level, with Polish and German partners.

Key Personnel:

Jean-François GANGHOFFER (male) is Professor at Université de Lorraine in ENSEM (Ecole Nationale Supérieure d'Electricité et de Mécanique), and his research activities take place in LEMTA (Nancy). He received a PhD degree from Ecole des Mines (Nancy, France) in 1992, after a joined international collaboration (PICS supported by CNRS) with the Dpt of Mechanical Engineering at Linköping University of Technology (Sweden). In 1992, he was involved as a post-doctorand student in an international project (PICS) with INM (Institute für Neue Materialen) at Saarbrücken University (Germany) on the setting up of constitutive models for the structural relaxation in glass / ceramic composites. From 1992-2000, he held a researcher position within CNRS in Mulhouse, France, where he carried out research activities in the fields of adhesion, damage and fracture mechanics. He spent one year (1996) in Civil Engineering at TU Delft, where he carried research on the mechanics of generalized continua. He joined ENSEM (Nancy, France) as a full Professor in 2000, where he is currently active (Pr. Classe exceptionnelle, the highest academic rank in the French academic system). His research activities span a large spectrum in both theoretical and computational mechanics of materials, including topics such as the mechanics of fabric, biomechanics, and symmetry analysis. Scientific record: he is the author or co-author of more than 120 refereed papers and 100 conference Proceedings, 15 book chapters and has been invited to give lectures in more than 40 International Conferences. H-index (Google Scholar): 15. He has organized or co-organized about 15 Conferences or Minisymposia at international Conferences. He is currently teaching continuum mechanics, nonlinear elasticity, mechanics of composites, contact mechanics. He has been coordinator of the bilateral French-Tunisian project UTIQUE on vascular grafts (2008-2012), of the French project MECAFIBRES supported by the ANR (Agence Nationale de la Recherche in France, http://www.agence-nationale-recherche.fr/en/project-based-funding-to-advance-french-research/). from 2008 to 2012, and he is presently coordinator of the French project INTERLOCK3D (2014-2018) supported by ANR, devoted to 3D fibrous media (budget is 1M€), involving a consortium of eight academic and industrial partenrs. He is coordinator of the bilateral PICS project with ENIT (Tunis, Tunisia) devoted to the mechanics of 3D textiles (2015-2017). He is involved in several collaboration projects at international level (Bulgaria, Canada, Germany, Poland, Russia, Switzerland, Tunisia), and is regularly invited at international conferences. He is collaborating with industrial partners such as SNECMA (France) and GoodYear (Luxemburg) on the topic of fibrous media.

He has organized or co-organized 15 Conferences and Minisymposia at international Conferences. He has supervised about 15 PhD students, and he is currently advisor of four PhD students. Jean-François Ganghoffer stayed at TU Eindhoven as invited Pr. during 6 months in 2006. He has been invited 6 weeks yearly at UBC (University of British Columbia, Vancouver, Canada) as invited Professor (2006-2010), where he was actively involved in both teaching and research. He has been invited for teaching and research at ETH (Zurich) 6 months in 2014. He is the founder and one leader of the GdR 3MF Mécanique Multiéchelles des Milieux Fibreux devoted to multiscale aspects of fibrous pedia,

http://projects.3sr-grenoble.fr/gdr-3mf/. He is the recipient of the Grand Prix de la Recherche of the Société Industrielle de l'Est in 2006.

Rachid RAHOUADJ (male) is Professor at Université de Lorraine in ENSEM (Ecole Nationale Supérieure d'Electricité et de Mécanique), and his research activities take place in LEMTA (Nancy).

He obtained a PhD from Université Technologique de Compiègne (1985), an Habilitation from Université de Lorraine in 2004, and was promoted to a full professor position in 2011. His research activities focus on Biomechanics and Bioengineering of both soft and hard tissues. He has over the last twenty years gained a strong experience in modelling the nonlinear behaviour of materials in the framework of irreversible thermodynamics. He is the author or co-author of about 50 publications and 75 presentations at international Conferences. He has been the advisor of 16 PhD thesis. He is since June 2013 Scientific Delegate at the AERES (Agency for Research and Higher Education in Paris, http://www.aeres-evaluation.com/). He is collaborating nationwide with Biopôle of Nancy, MSSMat Laboratory (ECP) (Dr. D. Durville), 3S-R Laboratory (Grenoble, Dr. L. Orgeas) and at international level with Nove de Julho University of São Paulo (Prs. R. Martins and R. Labat), University of Saskatoon, Canada (A. Cheviakov), and the Biophysics Institute of Sofia, Bulgaria (Dr. Mladenov). He is member of the French Société de Biomécanique http://www.biomecanique.org/, the GdR Mécanotransduction http://ivtv.ec-lyon.fr/GDR.html, MECAMAT http://www.mecamat.asso.fr/ and the World Association for Laser Therapy, http://waltza.co.za/about-walt/mission/.

Paul LIPINSKI (male) is Professor at Université de Lorraine in ENIM (Ecole Nationale d'Ingénieur de Metz) and his research activities take place in LABPS (Metz). He was graduated in Mechanics in 1975 at Warsaw University of Technology, Faculty of Mechanics and Technology. In 1975 he received a PhD degree from Institute of Fundamental Technological Research (Instytut Podsawowych Problemow Techniki) of Polish Academy of Sciences. During one year he continued his research in the same Institute under the scientific supervision of Pr. Janusz Klepaczko. In June 1980, he took the position of invited professor at Metz University, Laboratory of Mechanical Reliability under the supervision of Pr Guy Pluvinage. In 1985 he contracted the permanent position of Assistant Professor, first at Metz University and later at Ecole Nationale d'Ingenieurs de Metz (ENIM). In 1993 he received the Doctor of Science degree from Metz University. Currently, he is employed as a Full Professor (Classe exceptionnelle) of Mechanics at the Department of Mechanics, Physics and Mathematics of ENIM. Between 1998 and 2006 he occupied the position of Research Director at ENIM. He is an author of over 280 publications in journals and conference proceedings published in English, French and Polish, mostly on scale transition theories in material sciences and biomechanics. He was advisor or co-advisor of 35 PhD theses. His main research interests include: single crystal plasticity, homogenization, composite materials, micromechanics and biomechanics. He acts as a reviewer for many high-ranked international journals and member of the Editorial Boards.

Other researchers that will take part in the project:

MCF A.S. Bonnet (female)

MCF E. de Brosses (female)

MCF C. Dreistadt (female)

MCF A. Baldit (male)

MCF C. Laurent (male)

MCF J.F. Schmitt (male)

Selected relevant publications:

- 'A contribution to the mechanics and thermodynamics of surface growth. Application to bone external remodeling'. J.F. Ganghoffer. Int. J. Engng Sci., 2012, Issue 1, **50**, 166–191.

- ‘A micromechanical approach to volumetric and surface growth in the framework of shape optimization.’ J.F. Ganghoffer, J. Sokolowski. Int. J. Engng Sci., **74**, 2014, 207-226.
- ‘A 3D elastic micropolar model for vertebral trabecular bone from lattice homogenization of the trabecular structure’. I. Goda, M. Assidi, J.F. Ganghoffer. JMBBM. 2014 Jan;13(1):53-83. doi: 10.1007/s10237-013-0486.
- ‘3D plastic collapse and brittle fracture surface models of trabecular bone from asymptotic homogenization method.’ I. Goda, J.F. Ganghoffer, 2015. Int. Engng Sci., **87**, 2015, 58-82.
- ‘Development and mechanical characterization of porous titanium bone substitutes’. A. Barbas, A. S. Bonnet, P. Lipinski, R. Pesci, G. Dubois, JMBBM. 2012; 9, 34–44. doi : 10.1016/j.jmbbm.2012.01.008.

Selected relevant previous projects or activities:

Jean-François Ganghoffer is the coordinator of a PICS project supported by CNRS (2015-2017) supporting the mobility of researchers from Tunisia and France, focusing on higher order continuum models for bone.

He has been coordinator on the French side of a French-German summer school devoted to combined Biomechanics and optimization called ‘Evolutive Solid Bodies: from structural optimization to biological growth’, jointly organized by TUDO (Pr. Franz-Joseph Barthold) and Université de Lorraine in September 2013 (Munster, Germany, 08/09/2013-14/09/2013). A similar summer school is planned in October 2015 in Bollendorf (04/10-10-10/2015, Germany) on ‘Microstructural rearrangements and design modifications in heterogeneous materials’.

Significant infrastructure and/or major items of technical equipment:

Experimental set-ups:

- Hydraulic press MTS,
- Tensile/Torsion machines ZWICK/ROELL,
- Tensile machine INSTRON 50 Kn,
- Tensile/torsion machine for static and fatigue tests Instron 10KN,
- Tensile Machine ADAMEL,
- Double Hopkinson bar machine mounted on a horizontal IPN frame,
- High performance gas launcher capable of achieving speeds of 600 m / s,
- Small diameter gas launcher with interchangeable launch tube,
- Micro-tensile machine Kammrath&Weiss,
- 2 visco-analyzers METRAVIB (frequency ranges: 10-3 - 10 Hz and 1 - 103 Hz for a temperature range of -80°C to 450°C),
- Thermoforming machine ILLIG SB 100C,
- Zebris JMA system (Jaw Motion Analysis),
- Zebris EMG system (Electromyography).

Measurement equipment:

- Strain and kinematic fields measurements:
    - Vidéo-traction,
    - ARAMIS-5M (Stereo Image correlation),

- Thermal fields:
    - IR Camera Titanium (FLIR-CEDIP),
- Incoherent and polarized light transport based systems:
    - Lasers, optical cameras,
    - Liquid Crystals Retardators Meadowlark,
- Photoelasticimetry:
    - Transmission,
    - Reflexion,
- Digitalization system for structured light OptoTOP-HE:
    - OptoCat software,
- Immersive virtual reality system with software AMIRA,
- Alicona microscope (zoom microscope Infinite Focus IFM G4),
- Nanomograph EasyTom RX SOLUTIONS.

Calculation codes

- ABAQUS,
- MSC-MARC,
- LifeMod,
- GiD,
- CATIA V5 (CAO),
- SimDesigner,
- STAMPACK (stamping, embossing),
- VULCAN (casting),
- CADMOULD, REM3D (moult injection), FLUENT™.

The International Research Center for Mathematics & Mechanics of Complex Systems (M&MoCS)

The International Research Center for Mathematics & Mechanics of Complex Systems (M&MoCS) is a Research Center of the Università dell'Aquila (Italy). It was established by the Dipartimento di Ingegneria delle Strutture, delle Acque e del Terreno (DISAT) and the Dipartimento di Matematica Pura e Applicata (DMPA).

The Centre has the following institutional objectives:

a) promote, conduct and coordinate research activities, with particular attention to the development and entrenchment of scientific culture in the province of Latina;

b) promote initiatives for scientific liaison between researchers in mathematical fields and researchers in solid mechanics and fluids, operating both in Italy and abroad in the field of mathematical modeling for engineering;

c) promote, support and organize highly qualified educational activities, such as training, masters and doctorate courses;

d) encourage the promotion of mathematics and mechanics of complex systems through publications, conferences, seminars and exhibitions;

e) carry out consultancy and research for organizations and institutions;

f) disseminate knowledge of research undertaken by the Centre in the most appropriate ways.

The International Research Center for Mathematics & Mechanics of Complex Systems (M&MoCS) is a Research Center of the Università dell'Aquila (Italy). It was established by the Dipartimento di Ingegneria delle Strutture, delle Acque e del Terreno (DISAT) and the Dipartimento di Matematica Pura e Applicata (DMPA).

Key Personnel:

Prof. Ugo ANDREAUS (male) graduated in Structural Engineering (1978), Research Engineer at the University of Rome "La Sapienza" group H07A-Strength of Materials (1983-1991), associate professor group H07A-Strength of Materials (1991-2000), full professor group ICAR/08- Strength of Materials (2000-…). He was member of the Doctoral Committee in "Theoretical and Applied Mechanics" of the University of Rome "La Sapienza" (2000-…), and former editor of the polish journal Engineering Transactions as well as former technical supervisor of the Section "Eudossiana" of the Department (2001-2007). Teaching subjects: Dynamics of Structures (1982-'83, University of L'Aquila), Strength of Materials for Electronic Engineering (1990-'95, 1999-'00), Aerospace Engineering (1994-…), Clinics Engineering (2001-…), Electric Engineering (1993-'00), Materials Engineering of the materials and Transportation School of the Italian Army (1993-'98), Strength of Biomaterials for Biomedical Engineering (2004-...). Fields of scientific interest: Mechanics of Solids and Structures. Recent topics: free and forced response of discrete and continuous mechanical systems characterized by impact and friction (numerical simulation and experimental test); crack identification in a bi-dimensional continuous (beam-like) medium (numerical simulation and experimental test); structural analysis of prosthesized human joints; functional adaptation of bone tissue as an optimal control problem; interaction between bone tissue and bioresorbable material as components of a porous mixture; nonlinear dynamic analysis of the atomic force microscopy. He is the author of 46 papers in scientific journal, 45 contributions to congress, 4 papers in book, 1 scientific Monography, 2 scientific reports, 5 text books.

Prof. David STEIGMANN (male) graduated in 1982 at M.I.T. and received his PhD in 1988 at Brown University, Providence, R.I. (Thesis: *Tension-field Theory*. Adviser: A.C. Pipkin, Division of Applied Mathematics). Since 2005 to present he is Professor at Dept. of Mechanical Engineering, U.C. Berkeley (USA). He is Editor in Chief of *Mathematics and Mechanics of Solids* and is in the Editorial Board, among others, of *ZAMP (Zeitschrift fur Angewandte Mathematik und Physik)* and *International Journal of Non-linear Mechanics*. His research interests include Mechanics of thin films and thin-film/substrate systems; near-surface wave propagation and energy flux -Electromagnetic phenomena in solid mechanics; applications to thin-film/substrate problems -Surface stress, capillary phenomena, biological cell membranes, surfactant films in multi-phase fluid emulsions. He has also been active in Finite elasticity -Tensile (membrane) structures -Nonlinear three-dimensional mechanics of fabrics and Thin shells. He received many grants and awards, inter alia: Natural Sciences and Engineering Research Council of Canada (continuous support during the period 1989-1997 through Individual Research, Strategic grants); NATO Collaborative Research Grant (CRG950152), with R.W. Ogden of the University of Glasgow (1995-1998); Berkeley Junior Faculty Fellowship (1997); Powley Fund for Ballistics Research: A study of fibrous materials under ballistic impact loading; Electromagnetic Response of Polymer Films Infused with Nanoscale Magnetic Particles, Lawrence Livermore National Labs; Statistical Testing of Aluminum, Titanium, Lexan and Composites for Transport Airplane Rotor Burst Fragment Shielding (FAA/Boeing, Oct. 2002 to Apr. 30 2004, with T. Zohdi and (the late) W. Goldsmith).

Prof. Francesco dell'ISOLA (male) graduated in Physics in 1986 and received his Ph.D. in Mathematical Physics in 1992 (both at Università degli studi di Napoli Federico II). He is full Professor of Mechanics of Solids and Structures at University of Rome La Sapienza since 2005. He has been visiting professor at Virginia Polytechnical Institute and State University in 2000 and at l'Université de Versailles in

2005. Since 2012 he is Member of the Executive Committee of the International Research Center M&MoCS, University of L'Aquila, and for the period 2014 – 2018 he is Membre du Conseil scientifique de l'Institut des sciences de l'ingénierie et des systèmes – CNRS (France). He is in the Editorial Board (among others) of *PNRPU Mechanics Bulletin*, *Continuum Mechanics and Thermodynamics*, *Mathematics and Mechanics of Solids*, *International Journal of Electromagnetics and Mechanics*, and *Research in Nondestructive Evaluation*.

Among his research interests, there are: Mechanics of solids and structures and Vibration Control; Modeling of compressible fluid flow in deformable porous media; Saint-Venant's problem and Almansi problem for elastic micro-structured solids, for piezoelectric materials in linear and non linear contexts; Vibration control in beams connected to electric transmissions lines by means of PZT actuators); Mathematical Foundations of Continuum Mechanics; Variational Principles; Generalized Continua and their applications to Architectured materials; Systems with inextensible fibers and applications to composite mechanics; Mechanics of living tissues and their mathematical modeling; Mathematical models for phase transitions, capillarity and interface phenomena. He is co-author of 124 papers on international journals and co-author of an US-patent 6546316, Two dimensional network of actuators for the control of damping vibrations. Net-Control systems of structural vibrations. he has been Invited as speaker in 70 seminars and organizer of 16 International conferences and Schools.

Prof. Antonio CARCATERRA (male) graduated in Mechanical Engineering, Faculty of Engineering, University 'La Sapienza', Rome in 1991, and received his PhD Degree in Theoretical and Applied Mechanics in 1994. since 2010 he is Professor of Vehicle Dynamics and Principle of Micro/nano Mechanical Design at the Dept. Mechanics and Aeronuatics, University of Rome La Sapienza and has been professor of Mechanics at Carnegie Mellon University, Pittsburgh (2005-2010), USA. He is the director of the Joint Lab Technology of Marine Vehicle; Member of the Scientific Council of Sapienza Innovazione, of INSEAN (National Institute for Ship Science) and of CRR (Centro Roma Ricerche) and member of the Advisory Board of CNIS (Center for Engineering Nanotechnology of La Sapienza). He acted as an advisor of the National Science Foundation.

He is actually director of several national and European research projects. He is author of more than hundred and fifty research published papers on international journals, and conference proceedings and author of several patents currently applied in industry.

He has been invited lecturer and keynote speaker in many international conferences and visiting professor in several universities in Europe and in the United States. His scientific interests include dynamics, uncertain systems, vehicles and multidisciplinary problems. He has the following patents: "Gear mechanism for the exact steering of vehicles" – 1996; "Micro-vibro motor based on the electrical activity of the membrane of a living cell", together with prof. M. Mazzanti - June 2005; "Novel device for damping mechanical vibrations based on group of phase incoherent resonators, in particular for the realization of a micro/nano-structured material with super- damping properties ", together with prof. A. Akay - March 2005.

Prof. Victor A. EREMEYEV (male) was born Mart 7, 1963, in v. Piliponovka, Ukraine, USSR. Married, with two sons and a daughter. Languages: Russian (mother tongue); English (fluent spoken and written); Polish (spoken); German (spoken and written), French (basic). Graduated Rostov State University at 1985 (diploma in Mechanics). Defended PhD in Rostov State University in 1990 (title: *The stability of two-phase nonlinear thermo-elastic bodies*). Awarded Dr. hab. (Doctor of science of Physics & Mathematics) at Institute of Problems of Mechanical Engineering of Russian Academy of Science, Saint-Petersburg (title: *Mechanics of two-phase bodies with microstructure under finite deformations*). Scientific record: 87 publications indexed by Scopus, 8 written and edited books in English, Russian and Spanish. H-index: 15 (Web of Science), 16 (Scopus), 25 (Google Scholar). Citations: > 600 (Web of Science or Scopus); >1500 (Google Scholar). Actual affiliation: Otto von Guericke University Magdeburg, Germany. Among his Research Topics: Mechanical Engineering, Civil Engineering, Applied and Computational Mathematics, Structural Engineering, Fluid Mechanics, Solid and Fluid Mechanics.

Other researchers that will take part in the project:

- **Prof. Nicola RIZZI** (male)
- **Prof. Dionisio Del VESCOVO** (male)
- **Prof. Micol AMAR** (female)
- **Prof. Alberto BERSANI** (male)
- **MCF Angela MADEO** (female)
- **Dr. Ivan GIORGIO** (male)
- **Dr. Daria SCERRATO** (female)

Selected relevant publications:

- Andreaus, U., Casini, P., Vestroni, F.

  Non-linear dynamics of a cracked cantilever beam under harmonic excitation

  (2007) International Journal of Non-Linear Mechanics, 42 (3), pp. 566-575. Cited 61 times.

- Andreaus, U., Batra, R.C., Porfiri, M.

  Vibrations of cracked Euler-Bernoulli beams using Meshless Local Petrov-Galerkin (MLPG) method

  (2005) CMES - Computer Modeling in Engineering and Sciences, 9 (2), pp. 111-131. Cited 34 times.

- Alibert, J. J., Seppecher, P., & Dell'Isola, F. (2003). Truss modular beams with deformation energy depending on higher displacement gradients. Mathematics and Mechanics of Solids, 8(1), 51-73.
- Dell'Isola, F., Gouin, H., & Rotoli, G. (2009). Nucleation of spherical shell-like interfaces by second gradient theory: numerical simulations. arXiv preprint arXiv:0906.1897.
- Steigmann, D. J. (2004). Equilibrium theory for magnetic elastomers and magnetoelastic membranes. International Journal of Non-Linear Mechanics, 39(7), 1193-1216.
- Nadler, B., Papadopoulos, P., & Steigmann, D. J. (2006). Multiscale constitutive modeling and numerical simulation of fabric material. International Journal of Solids and Structures, 43(2), 206-221.

Selected relevant previous projects or activities:

Prof. Ugo Andreaus:

- Local coordinator of Rome research unit of PRIN 2010-2011 (Reserch Project of National Interest).

Prof. David Steigmann:

- Natural Sciences and Engineering Research Council of Canada (continuous support during the period 1989-1997 through Individual Research, Strategic grants).
- NATO Collaborative Research Grant (CRG950152), with R.W. Ogden of the University of Glasgow (1995-1998).
- Statistical Testing of Aluminum, Titanium, Lexan and Composites for Transport Airplane Rotor Burst Fragment Shielding (FAA/Boeing, Oct. 2002 to Apr. 30 2004, with T. Zohdi and (the late) W. Goldsmith).

Prof. Antonio Carcaterra:

- Responsible for the SIMBIOS Project (2004-2005). The SIMBIOS project is an interdepartmental joint project (Department of Mechanics and Aeronautics and Department of Developmental and Cell Biology of the University “La Sapienza”, Prof. M. Mazzanti) aimed to study the interaction of a living cell and an inorganic electro-mechanical device.
- European Project SEANET, 1998-2001. Region Coordinator for Italy and domain expert for the project Statistical Energy Analysis- NET, related to the development of energy methods in vibro-acoustics. Project duration 3 years, 24 partners (universities, research centers and industries). In the frame of the SEANET project he organized the European Workshop on Statistical Energy Analysis , held in Rome, March 2000.
- European Project ‘NORMA’, 2000-2001. Coordinator of the workpackage ‘Hydrodynamic noise’ for the Project ‘NORMA’ (NOise Reduction for Marine Applications) as scientific director of the . The research was related to the analysis of noise and vibration comfort in high-speed vessels. Duration of the project 3 years, 9 partners (universities, research centers and industries)

Significant infrastructure and/or major items of technical equipment:

- Impact Hammer (Bruel & Kjaer) type 8204.
- 2 accelerometers (Bruel & Kjaer) type 4397.
- Shaker and controller (LDS) type V406.
- Insulating Table (Newport).
- Laser Scanning Vibrometer PSV-400.
- Acquisition Cards: NI 4472 Series, NI PCI-4474, NI PCI-6052 E.
- Laser Vibrometer (Polytec) PSV-400-H4.

Technical University Dortmund

TUDO University (TUDO) was founded in 1968. With about 32800 students in 16 faculties as well as about 6200 employees – among them 300 professors – TUDO University already has the dimension of a small city. TUDO University is one of Dortmund's largest employers. It has done much to help transform the city and the Ruhr region into a high-tech and service hub and a cultural metropolis. One out of every ten students comes from abroad. Under the label “UA Ruhr” the three Ruhr universities (TUDO University, Ruhr University Bochum, University of Duisburg-Essen) opened its first liaison office in New York in 2004. Other offices in Moscow and Sao Paulo/Rio de Janeiro followed. Furthermore, the individual faculties also have their own cooperation agreements and programs and/or are members of an international university network.

In direct vicinity to the campus, two high tech centers, the TechnologieZentrumDortmund and Europe's largest technology park, successfully transform research ideas into industrial and business formats. Modern research is often interdisciplinary. This is especially visible in the four profile areas of TUDO University. In Production and Logistics, researchers develop innovative ideas for processing

materials and shape the management of goods flows and production processes together with experts at the Fraunhofer Institute for Material Flow and Logistics. Chemical Biology and Biotechnology, the second profile area, brings together several strong partners. Here, Germany's largest Faculty of Biochemical and Chemical Engineering, Dortmund's Max Planck Institute of Molecular Physiology, and the Faculty of Chemistry cooperate with other research institutions. In the third profile area, Modeling, Simulation and Optimization of Complex Processes and Systems, computer scientists, mathematicians, statisticians, engineers and economists work together to model technical processes and economic developments. A fourth key area is Youth, School and Education Research, providing significant impulses for national and international educational policies.

TUDO University is an independent research site and obtains research grants of more than 70 million Euros per year. This includes funding from the German Research Foundation (DFG) for several collaborative research centers, transregional collaborative research centers, research units and priority programs. The grants also support young scientists who come to TUDO University for its exceptional Ph.D. programs including DFG research training groups and NRW research schools. TUDO University has a strong track record related to FP7 projects. The infrastructure for handling large European projects is available and well-established at TUDO University. TUDO University is a leading technically oriented research university with focus and strengths in engineering, natural sciences and transfer of advanced technologies. As leading interdisciplinary research institution the Department of Mechanical Engineering and the Department of Civil Engineering include all key scientific areas relevant for material characterization, modelling and simulation, production technology – from fundamental research to establishing new technologies. Excellent computational facilities – including a high performance computing centre – together with state of the art software packages for training and to perform advanced modeling and simulation are well-stablished and can be considered as basic equipment.

Group of Mechanics of Solids and Structures

The group of Mechanics of Solids and Structures at TUDO consists of the Institute of Mechanics at the Department of Mechanical Engineering, the Division of Numerical Methods and the Division of Mechanics, Statics and Dynamics – both at the Department of Civil Engineering. The group's work and objectives focus on the modeling, simulation and characterization of the mechanical behavior of solid materials and structures. Theoretical modeling aspects include physics-based multi-scale formulations in combination with advanced computational algorithms. The group is part of a Graduate School Simulation-based Microstructure Design and regularly organizes Ph.D. seminars and Ph.D. summer-/spring-schools. Within this twinning program, the group of Mechanics of Solids and Structures at TUDO shall formulate on overall viewpoint on biomechanics and mechanobiology which spans from the continuum, multi-scale and multi-physics bases and the corresponding finite element formulations to sensitivity driven structural optimization of biomechanics-related phenomena and design applications.

There will be 7 professors and 10 PhD students and post-docs from the Group of Mechanics of Solids and Structures at TUDO University that will be involved in the BATEAU project.

The main scientific fields of interest of the group are:

1 Multi-x

- multi-scale modeling – microstructure evolution, from statistical mechanics to computational homogenization
- multi-physical modeling – coupled problems in solid mechanics including different diffusion processes and thermal -, electric -, magnetic coupling
- multi-disciplinary – driving engineering applications and technology by solid mechanics, applied mathematics, materials science, mechanobiology, medicine

2 Material characterization

- measurements of mechanical and thermal fields
- complex loading paths – tension/compression/torsion, biaxial, inhomogeneous deformations
- cyclic behavior and dissipation
- interaction material/process during forming

3 Modeling and Simulation

- advanced methods in numerical simulation and material modeling
- non-linear programming, parameter identification, optimization methods
- problem-specific finite element formulations including remeshing techniques, interface formulations, phase-field and level-set formulations
- implementation and advanced algorithmic treatment of nonlinear constitutive relations – including inequality constraints – in iterative finite element programs

Scientific topics

- material modeling for multi-physical behavior of solids including thermal -, electric -, and magnetic coupling
- modeling of functional materials and material adaptation
- micromechanical modeling of local inelastic processes on different material length scales
- mechanically and thermally induced microstructure evolution in solids
- multi-scale and multi-physics modeling of the behavior of single- and polycrystalline smart/active materials
- development of stable numerical schemes and robust algorithms

Subjects of research work

- modeling and simulation of different classes of materials such as living biomaterials (e.g. (cancellous) bones, vessels, muscles), polymers (e.g. electro- and magnetoactive polymers), ceramics (e.g. piezoceramics), metals (e.g. shape memory alloys, trip steel)
- inelastic response (damage, relaxation, creep, plasticity, phase transformations) and thermomechanical behavior of solids at large strains
- process simulation in production engineering – machining, such as cutting and grinding, and forming technology, such as sheet metal forming and massive forming

Industrial and societal applications

- biomechanics – modeling of growth and remodeling towards tissue engineering
- modeling of wind power plants – lifetime prediction of gearbox bearings
- mechanics in production technology – modeling and simulation of forming and machining processes towards energy efficient production and lightweight constructions
- environmental mechanics – degradation of organic waste

Staff

- 7 Researchers and academics
- 17 Doctoral students
- 4 Post-doctoral

Description of the Institute of Mechanics

The Institute of Mechanics at the Department of Mechanical Engineering includes two full professors, two Assistant Professors, one Senior Researcher, three post-docs, eleven Ph.D. students, three non-scientific staff members and 25 undergraduate students. It has excellent computer facilities and expands the experimental equipment of the department with a laboratory for basic material characterization. The course programme is highly research oriented and includes advanced courses at the Bachelor, Master, and Ph.D. level. The institute currently participates in two graduate (Ph.D.)

schools. It has excellent and experienced staff at the intersection of mechanics, materials science and applied mathematics and establishes advanced constitutive models for different classes of materials together with state-of-the-art numerical methods. Experienced administrative staff is established.

Main scientific topics

1. Adaptation of hard biological tissues

- Growth and remodeling of hard biological tissues

Multi-scale modeling and simulation of adaptation – changes in shape, mass, volume, anisotropic material properties – under mechanical loading. Interactions with other solid bodies such as implants. Relations to structural design and topology optimization.

- Piezoelectric response of hard biological tissues

Modeling and simulation of material response of hard biological tissues, such as bones, under electromechanical loading. Adaptation and healing driven electrical stimuli.

2. Adaptation of soft biological tissues

- Growth and remodeling of soft biological tissues

Multi-scale modeling and simulation of adaptation – changes in shape, mass, volume, anisotropic material properties – under mechanical loading.

- Aging of soft biological tissues

Change in material properties, such as stiffening and reduced residual strains, with time. Constitutive response on different time scales.

- Activation of soft biological tissues

Active contraction of biological tissues such as muscles. Electrical activation stimulus, cardiac infarction, growth and degradation.

- Properties and design of soft biological tissues

Interaction of residual stresses and anisotropic composite structures. Design functions based on minimization of maximum principal stresses, minimization of specific strain measures, changing axes of anisotropy.

3. Applied optimization and structural design

- Inverse multi-scale analysis

Numerical inverse homogenization strategy to recover material parameters of the microstructure by using results of macroscopic tests. Coupling of the nonlinear optimization methods, such as Levenberg-Marquardt-based algorithms, with multi-scale finite element formulations.

- Efficient algorithms for inverse problems in elasticity imaging

Numerical inverse strategy to identify the shear modulus distribution in biological soft tissue in order to detect cancerous tissue.

4. Smart materials

- Electroactive polymers

Multi-scale constitutive modeling of electroactive polymers, in particular dielectric elastomers. Viscous behavior, stability analysis and simulation of energy harvesting systems.

- Magnetoactive polymers

Constitutive modeling of magnetoactive polymers including calibration based on advanced experiments. Anisotropic behavior and viscous effects. Design of damping devices.

- Piezoceramics

Multiscale modeling of piezoceramics. Laminate-based switching models for single crystals. Efficient simulation of polycrystals based on polygonal finite elements. Rate- and size-dependent effects.

5. Micromechanical modelling of solids – solid phase transformations

- Quasiconvexification

Application of quasiconvex analysis to the modelling of solids and solid phase transformations. Approximation of the quasiconvex energy hull via discretization and parametrization of the material's microstructure, e.g., via laminates of different order or via the Finite Element Method.

- Local interactions between micromechanical processes

Constitutive relations for the local coupling and interaction of, e.g., phase transformations and plasticity or, in general, inelastic processes and the resulting temperature increase.

6. Computational inelasticity

- Modeling of evolving material symmetries at different scales

Micromechanical models including crystal plasticity simulations and phase transformations. Macroscopic models for the description of evolving material symmetries through evolving higher-order tensors – distortional hardening models.

- Thermomechanically coupled inelasticity at finite strains

Thermodynamically consistent modeling of thermomechanically fully coupled problem. Novel coupling formulation for more realistic temperature predictions.

- Efficient numerical formulations based on incremental energy minimization

Discretization of the generalized postulate of minimum incremental energy (stress power). Variational constitutive updates.

7. Interfaces at different scales

- Modeling of material interfaces at the atomistic scale

Application of molecular dynamics simulation in order to analyze the effect of material interfaces in bulk materials. Computation of evolving material interfaces and microstructures.

- Modeling of material interfaces at the continuum scale

Novel constitutive models for coherent and non-coherent interfaces at finite deformations. Phase field approximations of the sharp interface problem.

- Homogenization of material interfaces

Atomistic to continuum homogenization by means of equivalence principles such as energy equivalence.

The Institute of Mechanics at the Department of Mechanical Engineering has several international collaborations – in addition to many national collaborations – in different fields of research. These collaborations include joint project activities and applications as well as joint organization of conferences, minisymposia and summerschools. The research group of the Institute of Mechanics has many joint publications with international research groups and realizes frequent exchanges and visits of senior staff and Ph.D. students.

These collaborations include the field of biomechanics and the modeling and simulation of active biological tissues, adaptation and wound healing – such as the collaborations with Stanford (US, Prof. E. Kuhl), University of Delaware (US, Prof. R.P. Gilbert), University of Connecticut (US, Prof. D. Pierce, TU Graz (Austria, Prof. G. Holzapfel), University of Zaragoza (Spain, Prof. E. Pena Baquedano, Prof. M.A. Martinez, Prof. J.M. Garcia Aznar), University of Madrid (Spain, Prof. J.M. Goicolea). These activities are also reflected by the Mini-Workshop at the Mathematisches Forschungsinstitut Oberwolfach (Germany, November 2015) on "Differential Growth, Morphogenesis, and Pattern Selection" organized by Prof. K. Garikipati (US, Ann Arbor), Prof. A. Goriely (UK, Oxford), Prof. E. Kuhl (US, Stanford), Prof. A. Menzel, (Germany, Dortmund). Activities in the development of inverse and numerical methods are jointly driven together with the University of Utah (US, Prof. E. Cherkaev) and the University of California at Berkeley (US, Prof. T. Zohdi). Joint research activities in the field of modelling and simulation of polymers – in particular electroactive and magnetoactive polymers – are established with Lund University (Sweden, Prof. M. Ristinmaa), Ben Gurion University (Israel, Prof. G. deBotton), University of Trento (Italy, Prof. M. Gei), Johannes Keppler University (Austria, Prof. Z. Major), University of California at Berkeley (US, Prof. S. Govindjee). The modeling and simulation as well as the experimental investigation of ferroelectrics is part of the joint research collaborations with the University of Oxford (UK, Prof. J. Huber) and the Indian Institute of Technology Madras (India, Prof. A. Arockiarajan). Smart materials, such as shape memory alloys are in the focus of the joint research activities together with the Universite de Lorraine (France, Prof. T. Ben Zineb), ParisTech (France, Prof. Y. Chemisky, Prof E. Patoor), Texas A&M (US, Prof. D.J. Hartl, Prof. D.C. Lagoudas). Moreover, advanced inelasticity models are jointly elaborated together with the University of California at Berkeley (US, Prof. P. Papadopoulos).

Description of the Division of Numerical Methods

The research group at the Divison of Numerical Methods focuses on structural optimization and sensitivity analysis with emphasis on biomechanics such as growth. Here, a fundamental continuum mechanical viewpoint allows a representation which is optimal suited for inverse problems and their subsequent numerical treatment.

Main scientific topics:

1. Continum mechanics of inverse geometry problems including growth

- Variational design sensitivity analysis in nonlinear solid mechanics

Application of variational methods to sensitivity analysis at large deformations. Efficient and robust numerical algorithms and implementation within the context of the Finite Element Method.

- Structural optimization of nonlinear problems of mechanics

Topology optimization and optimization of material's microstructures. Refinement of nonlinear finite element methods indicated by structural optimization.

The group collaborates with Prof. J.-F. Ganghoffer, Nancy, on "Evolutionary Solid Bodies" (ESB). A series of summer schools (2013, 2015) are organized to link physically induced structural rearrangements (modeled in the framework of continuum mechanics) with engineering induced design modifications (from structural optimization).

Description of the Division of Mechanics, Statics and Dynamics

The research group at the Division of Mechanics, Statics and Dynamics focuses on multi-scale material modeling and simulation of different classes of materials. These include applications in the field of biomechanics, such as the modeling of the human liver and articular cartilage, as well as computational inelasticity, such as the modeling of steel solidification. Moreover, the research group works on advanced computational homogenization approach for, e.g., fluid saturated porous media.

Main scientific topics:

1. Continuum Mechanics

- Thermodynamics and Finite Element Method

Different applications in advanced simulations in solid mechanics, such as solidification of steel, landfill and soil remediation.

2. Multi-scale Modeling

- Advanced computational homogenization

Multiphase theory based on mixture theory and theory of porous media. Finite Element squared formulations for coupled problems.

3. **Biomechanics**

- Growth and remodeling

Modeling of the liver, cartilage and arterial wall. Fluid and components transport in porous media. Diffusion-advection-reaction modeling.

The group collaborates with several international institutions and researchers on different scientific fields and applications. These include TU Graz (Austria, Prof. G. Holzapfel), Columbia University (US, Prof. A. Ateshian), University of Connecticut (US, Prof. D.M. Pierce) in the field of biomechanics, and the University of California at Berkeley (US, Prof. T.I. Zohdi, Prof. P. Papadopoulos) in the field of computational mechanics.

Key Personnel:

Prof. Dr.-Ing. Andreas MENZEL (male) graduated in Civil Engineering in 1997 at Leibniz University, Hanover. From 1997 to 2002 he was employed as a Research Assistant at TU Kaiserslautern where he received his PhD degree in 2002 and was awarded the Habilitation for Mechanics in 2006. Professor Menzel worked as a temporary professor at Siegen University from October 2006 to September 2007. Since September 2007 he has been employed as a Professor at the Institute of Mechanics, TUDO University, and holds a double affiliation with the Division of Solid Mechanics at Lund University, Sweden. He is an author of approximately 90 publications in peer reviewed international journals, approx. 20 publications in reviewed proceedings and approx. 65 publications in proceedings. He acts as a reviewer for approx. 50 international journals. His main research interests include: continuum mechanics, material modelling, computational inelasticity, biomechanics and smart materials. Professor Menzel has held Ph.D. courses on biomechanics at University of Zaragoza (Spain), Universidad Politecnica de Madrid (Spain) and at the University of Tampere (Finland). He has also filled the following positions at TUDO: Dean at the Department of Mechanical Engineering (10/2012–09/2014), Vice Dean at the Department of Mechanical Engineering (2009, 2012, since 10/2014) and member of the Senate of TUDO (since 07/2014). He has also been elected secretary of DEKOMECH (since 01/2015). Professor Menzel is involved in a running research project at Lund University funded by the Swedish Research Council (VR), as well as in four running projects at TUDO which are funded by the German Research Foundation (DFG).

Prof. Dr.-Ing. Jörn MOSLER (male) graduated in Civil Engineering in 1998 at Ruhr University Bochum (RUB). From October 1998 to December 2002 he was employed as a Research Assistant at Ruhr University Bochum where he received his PhD degree in 2002. From January 2003 to November 2004 he was a Research Associate at Ruhr University Bochum. From November 2004 to October 2005 he held a Caltech postdoctoral scholarship and DFG-scholarship, California Institute of Technology, USA. From November 2005 to January 2007 he was employed as a Senior Engineer at Ruhr University Bochum where he was awarded the Habilitation of Mechanics in 2007. From May 2008 to July 2011 he was employed as Professor of Computational Mechanics, Christian-Albrechts-Universität zu Kiel. Furthermore, from April 2008 to July 2012, Professor Mosler was Head of Division of Simulation of Solids and Structures, Helmholtz-Zentrum Geesthacht where he has also been an Adviser since August 2012. He has been employed as a Professor at the Institute of Mechanics, TUDO University since

September 2011. He is an author of approx. 50 publications in peer reviewed international journals and acts as a reviewer for approx. 40 international journals. His main research interests include: continuum mechanics, material modelling and computational inelasticity. Professor Mosler is involved in two running projects funded by the German Research Foundation (DFG).

Jun.-Prof. Dr.-Ing. Sandra KLINGE, nee Ilic (female) graduated in Civil Engineering in 1997 at Nis University, Serbia. After her studies in Computational Engineering as a DAAD scholarship holder, she received a Master degree (M.Sc.) at Ruhr-University Bochum, Germany in October 2002 and was awarded the Recognition for the Best Overall Grade. Professor Klinge was employed as a Research Assistant at Ruhr University Bochum from October 2002 through October 2014. She received her PhD in 2008 at Ruhr University Bochum and was awarded the Habilitation of Mechanics there in 2014. She has been employed as Assistant Professor at the Institute of Mechanics, TUDO University since November 2014. She is an author of 13 publications in peer reviewed international journals and of approx. 17 publications in proceedings. She also acts as reviewer for 11 international journals. Professor Klinge has been a member of the managing committee of the group for „Computeralgebra" since 2011. Her main research interests include: research areas: biomechanics, multiscale simulations, continuum mechanics, material modelling and inverse analysis.

Jun.-Prof. Björn KIEFER, Ph.D. (male) graduated in Mechanical Engineering in 2001 at Ruhr University Bochum. From January 2002 to December 2006 he was a Graduate Assistant Research at Texas A&M University, Dept. Aerospace Engineering where he received his PhD in 2006. He completed his Postdoc at the Institute of Applied Mechanics, Stuttgart University, in 2010. In February 2012 he was invited as visiting Professor to the Université Henri Poincaré, Nancy (ESSTIN). Professor Kiefer has been employed as Assistant Professor at the Institute of Mechanics, TUDO University since September 2010. He is an author of 15 publications in peer reviewed international journals, approx. 25 publications in conference proceedings and acts as reviewer for 17 international journals. His research areas include: Continuum Mechanics with Geometrical and Physical Nonlinearities, Constitutive Modelling of Active and Multifunctional Materials, Electro-Magneto-Mechanical Coupling Phenomena in Solids, Computational Mechanics of Coupled Problems, Micromechanics and Multi-Scale Modelling, Coupling of Phase Transformations, Plasticity and Damage. Since September 2011 he has been an elected member of the ASME Aerospace Division Adaptive Structures and Material Systems Branch. Professor Kiefer is involved in one running project funded by the German Research Foundation (DFG) and in one running project funded by Mercator Research Center Ruhr (MERCUR).

Dr.-Ing. Thorsten BARTEL (male) graduated in Civil Engineering in 2003 at Ruhr University Bochum (RUB). From April 2003 to July 2008 he was employed as a Research Assistant at Ruhr University Bochum where he received his PhD (Dr.-Ing.) in 2009. After having filled a position as Research Assistant from August 2008 through May 2009, he has been holding a permanent position as Senior Engineer at the Institute of Mechanics, TUDO University, since June 2009. Dr. Bartel is a member of the Faculty Council at the Department of Mechanical Engineering at TUDO (since 07/2014). He is an author of 12 publications in peer reviewed international journals, 2 publications in reviewed proceedings, 5 publications in proceedings and acts as reviewer for 5 international journals. His main research interests include: continuum mechanics, material modelling, computational inelasticity, phase transformations and smart materials. Dr. Bartel is involved in one running research project at TUDO funded by the German Research Foundation (DFG, research unit) and in one running research project at TUDO funded by MERCATOR Research Centre Ruhr (MERCUR).

Prof. Dr.-Ing. Franz-Joseph BARTHOLD (male) graduated in Civil Engineering at Leibniz University Hanover where he was employed as a Research Assistant from October 1988 to August 1999. In 1993 he received his PhD (Dr.-Ing.) there and was awarded the Habilitation of Mechanics in 2001 at TU Braunschweig. From September 1999 through September 2002 he was Course Director CSE at TU Braunschweig. From October 2002 to September 2003 he was employed as a temporary Professor for Mechanics at the University of Kassel. Since October 2003, he is employed as Professor, Division of Numerical Methods and Information Processing, Faculty of Architecture and Civil Engineering, TUDO

University. Professor Barthold is an author of over 40 publications in peer reviewed international journals and proceedings. His main research areas include: continuum mechanics, non-linear finite element method, structural optimisation and its sensitivity analysis. He is involved in two running projects funded by the German Research Foundation (DFG).

Prof. Dr.-Ing. Tim RICKEN (male) graduated in Civil Engineering in 1998 at Essen University where he was a research fellow from 1998 to 2002. In 2002 he received his PhD (Dr.-Ing.) there and also completed his Postdoc in 2006. From 2006 through 2011 he was employed as Assistant Professor (Jun.- Prof.) at the University of Duisburg-Essen, Civil Engineering Department. In 2009 Professor Ricken was a Visiting Professor at Columbia University, USA. After his employment as Acting Professor from April 2011 to September 2011, he has been employed as Professor at the Division of Mechanics Statics Dynamics, Department of Architecture and Civil Engineering, TUDO University, since October 2011. He has been a member of the Senate of TUDO since 2012. Professor Ricken is an author of approx. 40 publications in peer reviewed international journals and acts as reviewer for 20 international journals. His main research interests include: continuum mechanics, material modelling, porous media, biomechanics and solidification of steel. Professor Ricken is involved in seven running research projects at TUDO University funded by the German Research Foundation (DFG), EU (H2020), MERCATOR Research Centre Ruhr (MERCUR), and by members of the Industry (ThyssenKrupp Steel Europe).

Selected relevant publications:

- A. Arnold, S. Reichling, O.T. Bruhns, J. Mosler. Efficient computation of the elastography inverse problem by combining variational mesh adaption and a clustering technique. Phys. Medicine Biol., 55:2035–2056, 2010.
- F.-J. Barthold. A structural optimisation viewpoint on growth phenomena. Bulletin Polish Acad. Sci. 60, 247–252, 2012.
- S. Ilic, K. Hackl, R.P. Gilbert. Application of the multiscale FEM to the modeling of cancellous bone, Biomech. Model. Mechanobiol., 9:87-102, 2010.
- T. Ricken, D. Werner, H.G. Holzhuetter, M. Koenig, U. Dahmen, O. Dirsch. Modeling function-perfusion behavior in liver lobules including tissue, blood, glucose, lactate and glycogen by use of a coupled two-scale PDE-ODE approach. Biomech. Model. Mechanobiol., DOI : 10.1007/s10237-014-0619-z, 2014.
- T. Waffenschmidt, A. Menzel. Application of an anisotropic growth and remodelling formulation to computational structural design, Mech. Res. Comm., 42:77-86, 2012.

Selected relevant previous projects or activities:

Prof. A. Menzel was the German coordinator of the PPP individual related exchange program (2012–2013, funded by the German Academic Exchange Service – DAAD) with the University of Zaragoza (Spain) on the “Modelling and Simulation of Ageing and Atherosclerosis in Arteries”. The objective of this work was the qualitative and quantitative analysis of ageing processes and associated plaque formation in arteries which are typical for atherosclerosis.

Prof. J. Mosler is currently involved in the DFG funded Collaborative Research Centre project SFB 986 "Tailor-Made Multi-Scale Materials Systems – M³“. The ultimate goal of this project is to design artificial new materials with a hierarchical microstructure showing excellent properties.

Prof. F.-J. Barthold has been coordinator on the German side of a French-German summer school devoted to combined Biomechanics and optimization called “Evolutive Solid Bodies: from structural optimization to biological growth”, jointly organized by Prof. J.-F. Ganghoffer in September 2013 (Muenster, Germany, 08/09/2013-14/09/2013). A similar summer school is planned in October 2015 in Bollendorf (04/10-10-10/2015, Germany) on “Microstructural rearrangements and design modifications in heterogeneous materials”.

Significant infrastructure and/or major items of technical equipment:

Scientific and technical facilities of the Group of Mechanics of Solids and Structures at TUDO University are the following:

Experimental facilities

- Tension/compression/torsion machine (max 100 kN)
- Tension/compression machine (50% participation, max 10 kN)
- Tension/compression/torsion machine (15% participation, max 10 kN)
- Biaxial machine (in 2016, max 50 kN)
- High resolution thermal imaging system (ImageIR 8320 hp)
- High resolution digital image correlation system (ARAMIS 4M)
- Light-microscope

Computational facilities

- several CIP-pools for computer/simulation/modeling courses, exercises and training
- high performance computer centre at TUDO University
- additional local computer clusters for advanced parallel computations
- computer software such as, Fortran, C, C++, Matlab, Mathematica, Maple, FEAP, ABAQUS, DEFORM, ANSYS, FLUENT, PATRAN, GID, Tecplot, …

4.2. Third parties involved in the project (including use of third party resources)

No third parties will be involved in the project.

5 Ethics and security

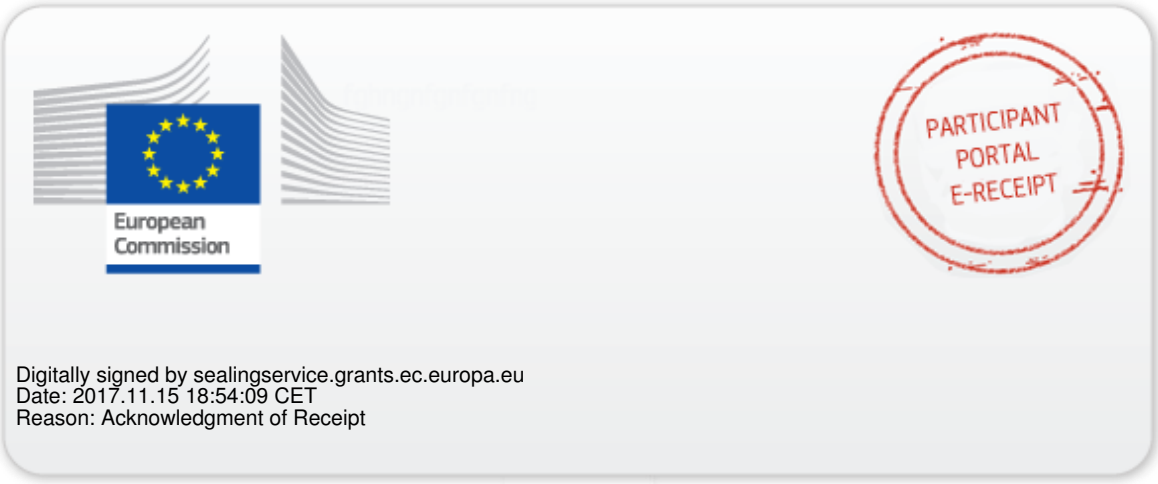
5.1. Ethics

Not relevant – no ethics issues have been entered in the ethical issue table in the administrative proposal forms.

5.2. Security

The project will NOT involve:

- activities or results raising security issues;
- “EU-classified information” as background or results.



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