

Addendum 1

The main lines of scientific development of STAR-UBB-N centres

The 6 Academic Centres bring the necessary expertise and interest to generate funding applications for internal or external competitions in the coming period, on topics detailed below for each Centre/Laboratory.

3.1. Virtual Labs (VL) – lines of research

1) the creation of computational intelligence patterns in information systems means to project, apply and develop computational paradigms inspired by different fields such as biology, sociology and linguistics. We refer especially to complex systems, fuzzy systems, neural networks, cognitive systems, nature-inspired systems and hybrid intelligent systems in which all these paradigms are contained. Among the lines of research already active we mention: intelligent methods of data-analysis, analysis of formal concepts, applications of computational intelligence in Bioinformatics, application of automated instruction techniques in software engineering, computational linguistics and methods of quantitative and qualitative analysis of texts, intelligent management and analysis of medical data, search-based software engineering, methods and applications of reinforcement learning. The applications will contain examples such as the extension of fuzzy chemometric methods for advanced evaluation of analytical and bioanalytical data concerning robust regression methods, studies related to the quantitative structure-retention/structure-properties/structure-activity relationships (QSRR/QSPR/QSAR) for the characterization and evaluation of active biological compounds (alkaloids, glycosides, polyphenols, organic/inorganic hybrid compounds) and also the optimization of new chromatographic and spectroscopic approaches for the analysis of pharmaceutical, food and environmental samples.

2) the study of inter-disciplinary problems involving mathematical modelling, optimization, numerical modelling and simulation, statistical analysis, cryptography and other. For example, the theory of modules investigates the structure of modules per se, and the theory of representations investigates the structure of category A of modules, aiming to also clarify the structure of algebra A , whose elements are considered to be more concrete, such as the endomorphisms of a vector space (i.e., by matrix). From here can follow applications such as those from the theory of categories and homological algebra, abelian groups and modules, representations of finite groups and finite-dimensional algebras, applications of the representation theory of related fields: the theory of codes, theoretical physics, chemistry, computational/quantum chemistry. In these latter fields, different subjects will be approached: polycations as vectors of genetic transfer, DNA polyplexes – genetic vectors, charge transfer in donor-acceptor compounds and organic heterojunctions, modelling of nanofluidics (e.g., transport in carbon nanotubes and ion channels) or modelling of dissolution/crystallization processes in calcites. Other subjects: the computational projection and characterization of some molecular systems for multimodal imaging Near-Infrared Fluorescence/Positron Emission Tomography, the exploration of the electronic structure and photophysical properties of molecules used in photodynamic therapy, the projection and characterisation of geometrical and electronic structure of molecular, supramolecular and nanoscale "host-guest" systems for drug delivery. At another level, one can pursue the generalization of statistical thermodynamics methods to the study of socio-economic phenomena, the study of synchronization processes in physical systems, the study of critical behaviour in physical systems, theoretical and numerical studies of complex atomic-scale systems (interaction of atoms and molecules with intense laser fields, hologram formation in the spectrum of emitted photoelectrons, ionisation of atoms and molecules by fast ions, dependence of differential total ionisation cross sections on the coherence length of the associated projectile wavelength, interference effects in the spectrum of emitted electrons).

3) software engineering – on topics such as the quality of software systems (evaluation and approximation of quality factors and their relationship with software metrics for large-scale software systems, with

emphasis on empirical methods), the analysis of formal concepts and applications of this method in different fields (both exact sciences and humanities), the program examination and analysis: formal mechanisms for specifying and verifying program properties, with applications in blockchain and security.

4) support for the study of complex systems using digital electronics, sensors and Internet of Things (IoT) - general Internet of Things (IoT) systems, data acquisition systems and laboratory instrumentation, sensors and usable communication infrastructure for robots, control of self-organising robots, development of algorithms based on dynamic systems.

5) discovery and development of substances for pharmaceutical use. For example, peptide inhibitors of some protein-protein interactions in the human and viral systems, with major applications as antiviral agents (the importance and need for these is reflected by the COVID-19 pandemic). Also, development of peptide inhibitors of protein-protein interactions in the human/bacterial system with major applications as antimicrobial agents. Antimicrobial resistance (AMR) is an increasingly pressing global issue for public health. Infections caused by antibiotic-resistant micro-organisms cannot be treated with standard methods, and therefore it leads to prolonged illness and consequently a high risk of mortality. The death rate of patients with serious infections treated in hospitals is about twice the rate of patients with infections caused by antibiotic-resistant bacteria. The development of recombinant enzymes with applications in enzyme replacement therapy combined with targeted transport and delivery of these protein drugs will also be pursued. The treatment of many diseases, including those caused by various pathogens, requires the controlled and targeted delivery of drugs by formulating them through novel pharmaceutical technologies that generally use nanomaterials whose structure and properties can be shaped and optimised.

6) the development of the existing microfluidics system at UBB and the development of an integrated minifluidics system. Lab-on-a-chip is a priority smart specialisation area for the European Commission's financial period 2021-2027. Lab-on-chip integrates on a miniaturised scale various technologies that allow the integrated performance of operations that would normally require an entire medical laboratory, i.e., a synthesis laboratory/section and an analysis of the molecules involved (chemistry/chemical engineering). Microfluidics is defined as the manipulation of the flow of very small amounts of fluid in micrometer-sized channels. Nanofluidics takes this miniaturisation procedure even further as it studies the individual movements of (macro) molecules in solution. The creation of multienzymatic nano and microfluidic systems will enable the realization and development of products and services in competitive systems through the development of new chemical, chemo-enzymatic and multienzymatic technologies with reduced costs of obtaining industrially relevant chemical compounds. Thus, in-stream biocatalytic processes are already considered indispensable for the development of sustainable technologies with environmental and health benefits. It will also ensure the monitoring and maintenance of the health status of the population by establishing efficient diagnosis and treatment algorithms, leading to substantial savings (hospitalisation costs, reduced medication), i.e., reduced costs for both diagnosis and treatment. The targets could be the production of industrially relevant compounds in the medical field through bioprocesses, the development of green technologies with a direct impact on public health, sustainable technologies based on enzymatic cascades for the efficient synthesis of compounds with pharmaceutical effect (e.g. L-DOPA, Ibuprofen derivatives, etc.), providing environmentally friendly alternatives for their industrial production, biodiagnostics using Lab-on-a-chip units, development of microchips, microreactors with different immobilised forms of enzymes on nanometric supports, with applications in the field of biodiagnostics of diseases induced by metabolic deficiencies of the human body (e.g. phenylketonuria, tyrosinaemia, etc.).

7) the development of some customized targeted therapies for oncological affections and other chronic inflammatory diseases and of some molecular diagnosis services of rare genetic diseases, viral diseases and different chronic diseases using molecular techniques – PCR, RT-qPCR and immunological techniques – ELISA/western blot for detecting viral antigens, autoantigens or type IgG/IgM/IgA immunoglobulins. This line of applied research has a strong social impact due to the high therapeutic index of these targeted therapies compared to conventional therapies (i.e., high therapeutic efficacy and low side effects). The

implementation of these diagnosis methods and respectively of targeted therapies have an important economic impact through decreasing the hospitalization costs and for the social insurances. The basic infrastructure will include as major equipment flow cytometer with FACS, ELISA Reader, qRT-PCR, ultracentrifuge, spectrophotometers, spectrofluorimeters and bioreactors.

8) the applied exploration and analysis in ecology and environmental conservation, the bioprospecting for discovering active biological compounds and exploring the functioning of living systems (genetics, biochemistry, physiology). The bioinformatics group will be able to serve both ecology and systemic biology research (which generates genetic/genomic data), and laboratory research *Diagnosis and therapeutical Bionanotechnologies* (School of Health) (through *omic* analysis – proteomic, transcriptomic or metabolomic for the assessment of the effects of therapeutics at cellular/tissue/systemic level).

The lab can support a range of research topics in ecology (e.g. understanding the functionality of particular ecosystems such as caves or salt lakes using metagenomics data - ecogenomics), medicine (study of viral genomes, pangenome of pathogenic microbial species, etc.). It will also aim to analyse annual tree rings in order to reconstruct, at local/regional/continental scales, natural/anthropic processes and phenomena (geomorphological, hydrological, climatic, anthropogenic impact, etc.) in forested areas. In this area, the development of lines related to dendrochronology will be pursued. Thus, it is primarily dendrogeomorphology (reconstructions of the spatio-temporal dynamics of the activity of geomorphological processes (with a seasonal, annual, decadal, centennial resolution) based on the macroscopic scale identification of growth anomalies due to the mechanical impact on trees produced by snow avalanches, debris flows (debris flows, hyperconcentrated flows), landslides, rock falls, mountain glaciers (mountain glacier retreat/advancement), microscopic scale identification of growth anomalies based on quantitative wood anatomy analysis of wood cells within growth rings. Also, dendroclimatology - reconstructions of climatic conditions - temperature and/or precipitation (at decadal, centennial, millennial scales) based on analysis of annual growth ring width variation, quantitative anatomical analysis (analysis of intra-annual variability of anatomical characteristics of growth rings), analysis of maximum latewood density (MXD), analysis of temporal variability of stable isotopes in annual growth rings. Also, dendrohydrology - spatio-temporal reconstructions of water level variability within peatlands in indirect correlation with rainfall regime (annual, decadal, centennial scale reconstructions), frequency and magnitude of floods, frequency and spatial extent of historical floods and palaeo-floods (based on the analysis of living and sub-fossil trees), dynamics of riverbeds (spatio-temporal evolution of meanders and islets). Last but not least, dendrogeochemistry - reconstructions of periods of forest disturbance due to historical pollution in mining areas based on the determination of the concentration of some chemical elements (Mg, Al, Si, P, S, Cl, K, Ca, Ti, V, Fe, Ni, Cu, Zn, As, Rb, Sr, etc.) in annual tree rings.

9) interdisciplinary research in advanced materials (including biomaterials, hybrid organic/inorganic systems, ceramics and other) with structural, morphological and surface properties controlled for targeted applications (e.g., the evaluation of detection capacity as sensors) of carbon-based composite materials and metallic nanoparticles, testing/evaluating the carbon-based composite materials and /or oxides of transitional metals/metallic nanoparticles as materials used in restoration, analysis of biocompatibility, selective catalysis), carbon storage (e.g., types of natural rocks suitable for storing the CO₂ excess extracted from atmosphere), or on the storage of radioactive and high-risk waste. The design, procurement and study of advanced materials and complex devices with predefined functional properties will generally pursue answers to current challenges in the fields of materials science and engineering in various areas of intelligent specialisation: advanced generation electronic components dedicated to sensors, information and communication technologies through the classical and quantum paradigm, devices for the conversion of various forms of energy, emerging applications in nanomedicine or environmental quality control. In line with the demands of today's society, an additional challenge in the design of new materials is the need to identify both environmentally friendly and energy efficient/resilient solutions. The broad spectrum of diversity and complexity of the applications pursued implies the use of a research and development paradigm based on the design and development of multi-scale predictive models for the materials, nanostructures and devices to be further developed and studied experimentally,

after the material parameters/properties controlling the functional properties pursued have been previously optimised in the predictive modelling phase. The aim will be to develop predictive models for predefined functional properties of classes of materials: magnetic, electrical, thermal, magneto-electric, magneto-caloric, biological, catalytic properties, etc. These models are developed at multiple scales: from analytical mathematics (classical/quantum formalism), ab-initio calculations, atomistic simulations to micromagnetic calculations, artificial intelligence computational algorithms based on neural networks. Simulation activities are followed by virtual design of new generations of devices or applications of complex materials.

10) applied geomatics research on the following lines:

- i. creating spatial and non-spatial database;
- ii. creating acquisition, processing and integration algorithms of databases;
- iii. development of complex G.I.S. spatial analysis models to identify vulnerability, risk (landslide risk, flood risk, environmental risk, social risk, etc.), their territorial impact and assessment of dysfunctions within territorial structures. Spatial analysis models allow the integration and analysis of spatial and non-spatial databases based on the logic of the process/phenomenon development mechanism (described by physicists in the field of the environment) implemented in geoinformation software (by geographers) through equations (developed by mathematicians) that describe the connections and interconnections between the components of the phenomenon/process, in order to identify spatial areas with a certain degree of vulnerability and risk induced on the analysed surfaces.
- iv. 3D modelling and spatial databases using laser scanning techniques, UAV aerial photo interpretation, digital photogrammetry (structure for motion). Geomatics research is mostly focused on the integrated analysis of the land surface as an infrastructure for the development of related processes/phenomena. The three-dimensional representation of territorial structures (digital elevation model, digital surface model, housing infrastructure, etc.) is one of the essential requirements for the development of spatial G-models. I.S. Laser scanning techniques, UAV aerial photointerpretation, digital photogrammetry is an integrated part of geomatics, techniques used in geographical, environmental science, geological, hydrological, urban planning research, etc.;
- v. implementation of spatial and related database storage solutions. The complexity as well as the large diversity of databases used in geomatics research requires complex storage solutions based on dedicated servers both in terms of the hardware and software components. The development and imposition of standards for specific databases is a topical geomatics research area involving computer scientists, geographers, geologists, biologists, etc., specialists who can impose a unanimously-accepted standardisation of both spatial and non-spatial (attribute) databases, depending on the domain to which they belong;
- vi. dissemination of research results and spatial databases through geoinformational applications. Making available, for information or download, the research results and databases obtained as a result of the acquisition, management and running of GIS spatial analysis models can be done through dedicated GIS servers using different communication protocols, depending on the needs (visualisation, storage, analysis). The WebGIS component of geomatics is the part that is developing the most, with a focus on developing GIS software that runs exclusively online (via WebGIS servers) and developing interfaces for online management and visualisation of spatial databases;
- vii. digital cartography - the production of cartographic representations based on digital maps obtained from the development of spatial analysis models.

11) research in the field of technological disaster management, including the following sub-areas: technological risk assessment (chemical industrial), technological disaster preparedness, technological disaster response and intervention.

12) advanced microscopy and elemental analysis research to characterise natural materials.

13) methodological developments in NMR spectroscopy on solids. Applications of NMR phenomena in spintronics. These will include theoretical calculations and numerical simulations using the Floquet formalism to describe systems of nuclear spins, or nuclear + electron spins. Also, the use of numerical

modelling for the development of new pulse sequences in NMR spectroscopy on solids with the aim of improving the resolution and sensitivity of spectra, highlighting interactions between spins inaccessible under certain experimental conditions (e.g. strong magnetic field, high rotation frequency, DNP NMR) by existing methods, and full 3D characterisation of the structure of complex (bio)molecules (e.g. torsion angles, internuclear distances, chemical bonds). Also perform NMR experiments on solids to demonstrate the functionality of the developed pulse sequences, or of the proposed experimental methods. Also, development of spintronic devices that work based on manipulation of nuclear spins (theory + experiment).

Among the sub-lines of this research topic one can note:

- i. development of heteronuclear or homonuclear decoupling sequences: in the case of complex (bio)molecules, the signals in the NMR spectra on solids are broad and overlapping, so that identification of all the chemical bonds in the system and therefore complete structure elucidation is impossible. For this reason, methods that narrow the signals in the NMR spectrum are needed;
- ii. development of heteronuclear or homonuclear decoupling sequences: the magic-angle spinning (MAS) NMR technique removes the anisotropic contribution from the NMR spectrum in order to narrow the spectral lines for better separation and interpretation. Sometimes, however, some of this contribution is of interest, in which case it must be reintroduced into the spectrum via so-called recoupling sequences. An example of this is the reintroduction of the anisotropic part of the dipolar coupling to determine internuclear distances;
- iii. development of sequences that enhance polarisation transfer between nuclei: One way to observe nuclei with low natural abundance (e.g., ^{13}C) is to perform polarization transfer from molecule nuclei that have high natural abundance (e.g., ^1H) to them, in order to amplify the magnetization of nuclei of interest that cannot be detected directly due to low natural abundance. Depending on the experimental conditions (magnetic field, rotation frequency, one-dimensional or multidimensional experiment) the optimal transfer function is different;
- iv. development of pulse sequences for multidimensional (2D and 3D) NMR spectroscopy: development of techniques to obtain torsion angles in the molecule, large internuclear distances, allowing the complete determination of the conformation of complex molecules;
- v. Methodological developments for the study of quadrupolar nuclei: about 70% of active NMR nuclei (nuclear spin $\neq 0$) are quadrupolar, i.e. have a non-spherical electron cloud distribution. Investigation of molecules containing such nuclei requires pulse sequences or techniques specifically developed for them;
- vi. nanoscale NMR phenomena in the terrestrial magnetic field. Applications in spintronics: although most spintronic devices are based on charge and electron spin manipulation, it has recently been shown that devices based on nuclear spin manipulation could offer higher performance. The aim of this research subarea is to develop spintronic devices that operate on nuclear spins, or on nuclear spins that have polarisation transferred from electron spins - similar to Dynamic Nuclear Polarisation (DNP) NMR, but at the nanoscale, in the earth's magnetic field, and at room temperature.

14) interdisciplinary theoretical and experimental approach to free radicals, in biomaterial physics, biopharmaceutical compounds, organometallic and coordinative compounds, environmental physicochemistry, catalytic reactions, polymerization reactions, human, animal and plant pathophysiology and other systems involving the presence of radicals, by Electron Paramagnetic Resonance Spectroscopy (EPR/RES). These include the analysis of foods sterilised by ionising radiation or drugs under pharmaceutical stress, the assessment of irradiation and storage conditions of sterilised products (by quantitative estimation of free radicals and their formation and recombination kinetics by direct observation and analysis of EPR spectra), the analysis of degradation products (by identifying the nature of the free radicals formed, by spin trapping method), evaluation of the antioxidant activity of some foods and natural extracts (using stable radicals such as nitroxide or DPPH and following their kinetics in paramagnetic neutralisation), study of biochemical, metabolic and physiological processes (where a large majority of metabolic/physiological processes occur as a result of dynamics involving the formation or transit through paramagnetic structures).

15) Development of Raman, fluorescence, luminescence and plasmonic spectroscopy applications - where i) recoverable and reusable materials (artificial intelligence in sorting plastic waste based on spectroscopic signal and logic gates), spectral databases and ultrasensitive Raman plasmonic methods (e.g., for identification of hazardous materials - toxins, pollutants such as plastics, others); ii) development of novel biogenic material-based composites applicable in nanomedicine and personalised medicine (targeted drug delivery, extended release, in situ Raman monitoring, Raman signalling), microfluidics (biological fluids in ordered three-dimensional biogenic nanostructures, ultrasensitive detection and monitoring exploiting plasmon resonance of noble metal nanoparticles), biofuels and renewable energy (bioreactors and intelligent in situ biochemical process monitoring based on spectral information from photosynthetic microorganisms); iii) development of spectral databases and ultrasensitive plasmonic methods for rapid in situ identification of hazardous materials (toxins, pollutants, others); iv) development of advanced methods and applications based on fluorescence and luminescence (e.g., new materials, quantitative and qualitative studies of pharmaceuticals, determination of fluorophores in food/beverages, detection of pesticides, water contaminants, etc.); v) development of new plasmonic nanoplatforms - as new generations of versatile point-of-care sensor devices.

A great deal of effort continues to be devoted in the scientific world to the development of cheap but effective innovative Point-of-care (POC) devices for direct and immediate deployment in various (bio)medical applications of interest to improve quality of life.

In this context, we aim to develop and implement new innovative, customized, portable plasmonic nanoplatforms that facilitate the sensitive, rapid and accurate real-time detection of biomarkers of interest and pollutants in real samples. This may involve the design of plasmonic nanobiosensors in colloidal solution, capable of providing real-world solutions for the determination and early monitoring of infections or inflammation, as well as ultra-sensitive detection of biomarkers of interest with high sensitivity, high specificity and portability.

We also consider:

- i. fabrication of plasmonic nanobiosensors/gold nanoclusters immobilized on paper by plasmonic calligraphy for the multiplexed detection of pesticides, biotoxins or different pollutants from different real environmental samples;
- ii. development of flexible non-invasive and versatile plasmonic platforms for real-time dual electrochemical-SERS glucose detection, thus being one step closer to the desired lab-on-the-skin devices for efficient glucose monitoring and diabetes management;
- iii. combining ultrasensitive detection with lab-on-a-chip technology by directly integrating self-assembled gold nanoparticles into microfluidic channels to develop innovative *point-of-care* devices for on-site diagnosis of clinically relevant biomarkers;
- iv. Development of new protein theranostic agents or NIR photoactivatable plasmonics for real-time surgical guidance and synergistic cancer therapy.

16) the development and validation of modern analytical methods using optic emission spectrometry in sources of microplasma with a completely miniaturised experimental spectrometric system and the implementation of such for the determination of mercury, arsenic, antimony in waste and plastic material, biodegradable packaging and other environmental methods. Also, the development of analytical methods of elements generating hydrides – arsenic, antimony, selenium, mercury, bismuth, tellurium – by high-resolution atomic absorption spectrometry with a continuous source of quartz furnace (HG-HR-CS-QFAAS) brings benefits as opposed to other known methods, a lower detection limit, high speed and precision. The validation of methods of analysis for determining the toxic metals from environmental samples involves using atomic emission spectrometry through the plasma capacitive coupled source as alternative to the known source, the inductive coupled plasma;

17) the development of green methods of preparation of samples and chromatographic analytical procedures for the investigation of pharmaceutical, phytopharmaceutical and food products and environment samples, both regarding the swabbing for prints, authentication and quality control of food

products, as well as studies on bioavailability of compounds of interest in food through *in vitro* and *in vivo* digestion simulation means.

A special attention is given to integrated analytical methods in order to characterise and analyse the bioactive compounds in natural sources, food, food supplements. Obtaining new natural products with improved biological properties, the study on the cumulated effect of the blend of food additives on the stability of colour and using natural compounds as raw material in the synthesis of hybrid biomaterials with medical applications are therefore of interest.

3.2. Virtual & Practical Engineering (VPE) – inter-/trans-/multi-disciplinary directions

1) nanomaterials: part of the study of materials, in particular thin films are a class of nanomaterials where one of the dimensions, the thickness, is in the nano range. Since this dimension is within the field of lengths particular to materials relative to various physical phenomena: electronic transport, magnetism, optical phenomena etc., the thin film allows for the control of the material's properties by mesoscopic effects determined by dimensionality (the alteration of the material thickness). Based on materials in the shape of thin films, we may elaborate complex multi-layered architectures with remarkable functional properties, which are determined, aside from dimensionality, also by the proximity to the level of surfaces and interfaces. Spintronics or spin Electronics holds a special place in the research on thin films and nanomaterials. Through the simultaneous exploitation of the electrical charge and of a quantic property of the electron – the spin, spintronic devices offer supplementary applicative valences in the fields of sensors and non-volatile storage technologies and information manipulation.

2) the assessment and development of innovative applications for the study of catalytic processes in the chemical and process industry in order to improve their sustainability by adding value to materials, using regenerative resources as raw materials, reducing the consumption of energy and the impact on the environment (decreasing the emission of carbon dioxide, SO_x, NO_x and solid particles in suspension, reducing the concentration of pollutants in waters):

- i. innovative systems of energy conversion simultaneous with carbon dioxide capture using solid gas heterogeneous processes through the method of chemical cycle (chemical/calcium looping);
- ii. systems of improving capture of carbon dioxide or of other gas emissions (sulphur and nitrogen oxides) through processes of liquid gas and solid-liquid gas absorption, using various configurations of the installation (fix and fluidised bed) and different solvents (mix, biphasic, eutectic etc.);
- iii. advanced systems of maximising renewable vegetal resources and residual fractions (cellulose, lignin, starch, pectin etc.) through highly selective sustainable and ecologic bioprocesses;
- iv. counteracting the negative effect on the environment due to pollutants from wastewaters and from running waters; recovery of energy and resources from valuable substances in wastewaters;
- v. ecologic bioprocesses for obtaining compounds of interest for the pharmaceutical industry (medicine and intermediaries), for the food and cosmetic industries (flavours, additives), biofuels;
- vi. innovative processes of enzymatic degradation of synthetic polymers (PET type) and the reconversion of degradation products into useful products to reduce the impact on the environment;
- vii. mathematical modelling, validation, optimisation and advanced control on heterogeneous processes for the development of sustainable industrial systems; the assessment of the technical economic and environmental impact of the industrial processes for the improvements of their sustainability;
- viii. the miniaturised study of heterogeneous catalytic processes in micro- and nano-fluidic systems (immobilised bio- and chemo-catalytics, multi-enzymatic processes) with the view to develop new artificial metabolic paths for the development of advanced sustainable technologies.

3) the preparation, characterisation and especially the applications of advanced materials:

- i. advanced nano-/bio-materials (e.g., ceramic materials; mesoscopic devices and materials with functional properties; materials with predefined properties; materials with properties for ionic recognition and functionalised magnetic nanoparticles; nanoparticles and nanofibers with special properties; innovative

systems of controlled and targeted release of medicine; biocompatible and biodegradable; materials based on mechanic and thermic improvement; new active principles and liposomal systems of storage and controlled release of active principled for the food industry, the pharmaceutic and the cosmetic industries; news materials for obtaining biocatalysts (enzymes and cellular cultures) with a higher activity and stability, for the development of sustainable processes).

ii. bioactivity, biocompatibility and sensory investigations;

iii. waste recycling (e.g., electrical and electronic equipment, batteries);

iv. electrochemical depollution of technological and waste waters;

v. electrochemical processing of materials (polishing, cutting, galvanising etc.);

vi. bio/electrochemical technologies (e.g., testing new technologies (chemical/electrochemical, on laboratory pilot plant); electrochemical corrosion and tribocorrosion studies (e.g., improving the anticorrosive resistance of metals through inexpensive and environmentally-friendly methods, biomaterials used in implants of soft and hard tissues and metallic surfaces in the medical equipment);

vii. physical chemistry studies (kinetics and thermodynamics) of absorption/desorption of natural materials to depollute of water, air and soil, and to model these processes;

viii. kinetic studies in a homogeneous and heterogeneous environment (e.g., dynamics of depollution of various sites (the dynamics of phytoremediation); studies of toxic industrial waste neutralisation (red mud); the dynamics of the alteration of active biological species; the dynamics of solid-liquid extraction).

4) studies on the storage of carbon underground environment (Carbon Capture Storage), of hydrogen, but also of other energetic resources (e.g., gas). Understanding the way salt deposits can be used to store hydrogen and other energetic resources, and identifying the possibilities of implementing such projects.

This research and development direction includes the use of knowledge related to hydrocarbon deposits and the identification of methods through which the depleted deposits may be used to store carbon long-term, thus contributing to the decrease in the negative impact carbon dioxide has on the environments the research-development-innovation direction work in synergy with the projects of carbon and other emissions capture.

5) the implementation and development of application of numerical modelling and virtual modelling, by innovative approach and the study of complex geological processes. Numerical modelling uses mathematic models to describe the conditions for geological processes, including those that can represent natural hazards, being used to also assess mechanisms by means of which carbon can be stored (e.g., saline aquifers in depleted deposits). Virtual/digital modelling of natural exposures, hills, galleries etc. is intensely practices in identifying the possible hazards, computing stability and even identifying the natural emissions of carbon dioxide or other emission that have a negative effect on the environment.

6) studies regarding the transmission of noises and vibrations, natural and anthropic, with micro and macro applications, Constructive and functional measures are considered, by: using certain new materials, the possibility of superficial deposits on existing materials and/or the alteration of the form of constructive elements. Moreover, the interposition of source and receptor of certain constructive elements functioning as passive or semi-active isolators is being investigated. An approached specific field refers to the study of PCB components and other microelectronic systems behaviour.

7) studies regarding the electric energy through photovoltaic solar, wind conversion, but also the making/storing of energy in hydrogen-based fuel cell systems, respectively on the impact of these technologies on the environment. The growth targets of the regenerable energy weight in the mix of energy demand the increase in efficiency of these technologies' conversion capacity, which will then have to be operated without sustainability support frames. The wind characteristic in most of locations is a high degree of variation of speed in time, which makes for the optimal operation – functioning in the maximum power point (MPP) to not be achieved. For this, we study the alteration of the constructive shape (the blades' aerodynamics, the nature of materials), the possibility to implement some adjustment and control strategies (improving the existing ones, proposal and experimental validation of new algorithms) meant to bring and keep the operation of wind turbines in MPP. Encouraging electric mobility also raises a problem in the storage of electric energy; the most common solution is based on accumulators (with a high

pollution and energy consumption print). Hydrogen-based fuel cells may be an attractive option. Aside from the optimisation of the conversion process, research also aims at the integration into the distribution network of electric energy, by analysing the so-called hybrid renewable energetic systems from the viewpoint of the chance for insuring a constant charge, targeting solar-photovoltaic systems connected to the network.

8) studies regarding the identification of systems and non-destructive control of engineering structures through methods based on the analysis of vibration signals (Structural Health Monitoring for static elements and Condition Monitoring for rotating machines). The techniques developed, although destined for signalling the presence of defects and their characterisation, can also be used in monitoring industrial processes or identifying mechanic properties of some special materials (composites, Functionally Graded Materials etc.). Artificial Intelligence is used intensively, and the following are considered:

- i. the creation of informatic applications allowing to identify modal parameters, with focus on natural frequencies, of high precision (including artificial intelligence);
- ii. the elaboration of behavioural models of engineering structures with normal and damaged functioning; identification of the defects' digital signature;
- iii. the creation of monitoring systems for engineering structures and the development of applications which signal the early stage of abnormal functioning and/or presence of flaws (including artificial intelligence).

(in collaboration with the School of Natural and Life Sciences)

9) studies regarding the analysis and assessment of technological risks and Natech risks (technological disasters caused by natural hazards);

- i. studies regarding the optimisation of territorial planning and emergency planning (evacuation in case of disasters) based on mathematic modelling and simulations of technological accidents and Natech;
- ii. studies regarding the optimisation of placing the plants inside the chemical sites based on the analysis of the effects of domino accidents.

10) studies regarding the composition of the atmosphere and the research of pollutants' movement through the air by using teledetection and modelling techniques:

- i. the study of air composition through teledetection for the purpose of researching climatic changes, identifying intrusions of potentially dangerous aerosol and assessing the local air quality. Monitoring aerosols, at ground level by measuring the concentrations of PM10 and PM2.5 material particles, and in the atmosphere – full characterisations of atmospheric aerosol (optical and microphysical parameters of aerosol, concentrations). Together with the aerosols, we also monitor a series of pollutant gases, and by using WRF-Chem their dispersion and transport on local and regional scale are being traced;
- ii. studies regarding the transport of pollutants through the atmosphere by modelling and simulating short- and long-distance processes.

11) studies regarding waste management:

- i. research on insuring the most efficient systems for advanced classification of municipal waste with means based on artificial intelligence, in order to streamline recycling processes;
- ii. research on the possibilities for intelligent planning of products in order to guarantee the recycling options, as stated by the principles of circular economy;
- iii. research of possibilities to obtain unconventional energies from organic waste (biomass);
- iv. research of possibilities to retrieve critical raw materials from electric and electronic waste.

12) studies on the monitoring of exposure to radon inside buildings in Romania and the impact on the community health. It aims to develop integrated technological solutions for continuous monitoring, control and remedy of pollutants within buildings, but also to apply certain preventive solutions in new buildings, by:

- i. monitoring of the concentration of radon and the air quality inside buildings by systematic passive tracing measurements, but also by developing new intelligent solutions continuously monitoring radon and pollutants from indoor air, by distance-transmission of data, starting from the SMARTRADON patented device (<https://www.smartradon.ro/>). The aim is to develop new prototypes adapted to the

different kinds of buildings, in order to give a full, qualitative and quantitative image of the main indoor pollutants: radon, CO₂, material particles (MP), volatile organic compounds (VOC), formaldehyde, as well as physical parameters (relative temperature and humidity); also, the aim is to develop an external module for monitoring atmosphere temperature and pressure. The elaboration of an indoor air quality index, by means of Artificial Intelligence, based on the incoming data captured by the prototype and some complex mathematical prediction models. The development and integration in a software's intelligent system for the prediction of radon and other pollutants concentrations in order to implement efficient systems of controlled remedy and in order to reduce the consumption of energy indoor;

ii. the development of advanced numerical models regarding the indoor air quality by identifying factors influencing the radon variations – the aim is to develop and integrate within the intelligent system some predictive models for the variations of radon and other pollutants concentration in order to implement efficient systems of reducing the concentration of these pollutants, with a reduced consumption of energy;

iii. compiling a Radon Map – mapping the traces of radon inside buildings in Romania in order to apply the national radon action programme, establishing the radon high-risk areas and prioritising;

iv. compiling a data basis for decision-making on prioritising the areas around Romania where measure for the control and remedy/prevention of the population's radon-exposure risk is applied;

v. developing solutions, methods and integrated technologies to continuously monitor, control and remedy pollutants indoor: the development of remedy methods and solutions within existing buildings in order to reduce the level of radon exposure; the development to certain prevention and control measures of radon permeation in new buildings;

vi. developing certain awareness programmes and elaborating information and communication guides to make the population and the interested factors aware of the risks associated to exposure to radon indoor;

vii. developing professional training programmes and organising trainings on the matter of indoor radon (*in collaboration with the School of Health*).

13) pedogeochemical multidisciplinary studies and studies of analytic chemistry-pedology-biology:

a. compiling a pedogeochemical map of closed down polymetallic mines;

b. evaluating the pollution with heavy metals in choosing the most adequate method of bioremediation;

c. compiling a map with extractible metals by way of *aqua regia* (e.g., Pb, Zn, Cu, Cd) and their bioavailability.

14) experimental research in hydroelectric plants on hydro-aggregates and numerical analysis of the mechanical behaviour of components of hydraulic turbines in static and/or variable stresses:

i. study of cavitation erosion on hydraulic turbines rotor blades;

ii. research on the insulation condition of electric generators.

15) studies regarding the properties of mechanical components obtained by additive manufacturing from polymers, polymer-based composites and metallic powders:

i. analysis of the influence of process parameters on the properties of mechanical components obtained by 3D printing through FFF (Fused Filament Fabrication), of pre-process factors and post-process treatments;

ii. analysis of the influence of process parameters on the properties of mechanical components obtained by 3D printing through the Material Jetting method;

iii. structures with light interior: the influence of filling patterns and the network density on the mechanical properties of structure with cellular interior; the variation of mechanical properties in relation to the main inertia axes; the numerical analysis of the mechanic behaviour of structure with cellular interior;

iv. analysis of the influence of process parameters on the structure and properties of metallic products obtained by Selective Laser Melting.

16) research regarding obtaining coating resistant to use, corrosion and fatigue from metal alloy powders (cobalt-based alloys, self-fluxing alloys), composites (Cermets), as well as polymeric materials:

i. optimisation of coating build-up technologies by process parameters variation;

- ii. optimisation of technologies of applying treatment after the build-up of strata, in order to improve their structure and properties;
- iii. development of the use-resistant coating and/or natural corrosion and corrosion by different compositions.

3.3. Bid Data & Machine Learning (BDML)

BDML advances directions aimed at next-level processing of digital content, by way of informatics solutions. Social sciences are based evermore on the analysis and processing of data and digital content (text, images, sound, video, sets and data bases). Such a space adapted to these demands, where the audio-video and using sets of big data allows for research within the academic schools (the economic field, communication, journalism, public administration, political sciences, public health), as well as inter-disciplinary research in the abovementioned fields. Also, using a platform such as Bloomberg allows researchers (tenures and associated teachers, doctoral students, visiting professors) to access a platform used by top professionals in management, fund management, business decision-makers, financiers or public policy makers (among the renowned universities offering a Bloomberg lab are Harvard University, Stanford, Yale and the University of Oxford). The Bloomberg platform offers data and information that may be integrated in the following research fields: Accountancy, Economics, Finances, Management, Marketing, Statistics and Econometry. Second to the opportunities offered to researchers in economics, the Bloomberg platform offers information and data useful to other fields, as well: Agriculture, Biology, Pharmacy, Energy, Environmental Science, Health, Sociology, Journalism, Public Policies. Other fields are also included: Entrepreneurship, creativity and innovation (oriented also towards the hospitality industry), Organisational Culture, the Management and Marketing of Touristic Destinations, Sustainable Development, Ethics and Business Behaviour, Impact of Digitalisation (IoT, AI) on companies, Leadership, Mobile-business, Local Rural and Urban Development, Organisational Development and Diagnosis, Occupational Integration and Professional Career, Social Policies, Social Inclusion and Fight against Social Marginalisation, Inequalities in the Educational System and Supporting Schooling, Ethnic Cultural Minorities, Inter-ethnic Relations, Migration, Gender Relations, Fighting against Violence and Abuse, Child Protection, Demography, The Role of Regional Actor of the European Union: Military Power, Civil Power or Normative Power, EU Competences to Mediate Disputes, Solve International Crises and Transform/Solve International Conflicts etc.

The main research directions:

- 1) developing new lines of research in the field of cyber-crime for identifying the operation modalities used as new elements in criminal activities. Directions:
 - i. creating a *repertoire* of cases in the legal practice, laws, methods of investigation, informatic programmes, academic articles;
 - ii. developing informatics programmes that, after attestation, may be used by legal organs to fight cyber-crime;
 - iii. offering expertise to judges and barristers in developing cases in cyber-crime;
 - iv. creating a complex online platform that facilitates the collaboration between researchers and experts in cyber-crime and cyber security, as well as improving the interaction with beneficiaries of research solutions.
- 2) using the *HoloLens2* technology and advanced *AI* algorithms that can spatially process the world around us in real time in order to:
 - i. model business processes by using simulations based on virtual and augmented reality technologies;
 - ii. risk prediction in the work environment;
 - iii. analysis of consumer's behaviour in virtual and augmented reality.

HoloLens2 technology includes high-performance sensors and advanced *AI* algorithms that may spatially process the world around us in real time. *HoloLens2* offers features that may be used in the

research of *AI*, with applications in the automation of certain business processes or in the prediction of risks in the work environment. It is integrated with Azure Cognitive Services and Azure Machine Learning, which make the system easy to optimise and scale.

3) using platforms such as Bloomberg to monitor and analyse the capital market in Romania, especially the stock market in Bucharest, both from the quantitative viewpoint of prices and transactional volumes, as well as an analysis of financial performance of listed companies based on their published financial-accounting states, by calculating time series of market indicators, profitability, efficiency, indebtedness, liquidity etc. Also, big data and machine learning will be used in the technical analysis of shares, through interactive graphs and in real time with the quotations of various real estate values.

4) the continuous development of the Romanian Economic Monitor portal, which is a research project including an online specialised platform, by means of which university researchers involved in this scientific process publish a series of relevant data in the form of interactive infographics, meant to show a comprehensive image, updated in real time showing the status of the Romanian economy. The main objective is to offer a real support to decision-makers in Romanian politics and economy by offering a starting point in mapping out predictive scenarios for a better protection of society, companies, their employees, supply chains in real economy.

5) elaborating some solutions to improve the decisional behaviour of entrepreneurs:

- i. identifying and analysing factors of influence over prices/taxes applied to market firms and elaborating prediction models as well as models of optimisation of their income;
- ii. perfecting the market segmentation process;
- iii. identifying optimisation solutions of the supply chain process.

6) *geographical/cross-cultural psychology* studies where macro-economic indicators be connected to aggregated indicators among the psychological and cultural features of the population, such as:

- i. identifying the psycho-cultural profiles favouring entrepreneurial culture, social economic growth, corruption etc.;
- ii. inferring certain psycho-cultural aggregated features based on social economic, political data regarding geographic and climatic characteristics etc.;
- iii. the study of health, including of mental health, at the level of the community and regions, by analysing the social economic variable and/or those regarding the use of health services.

7) large-scale *behavioural economics* studies, at the level of the community, correlating information on the individual or community features with the economic and consumption behaviour. Such studies may have more specific objectives, such as:

- i. the prediction of economic behaviour based on psycho-cultural features, as well as social economics ones;
- ii. the development of intervention strategies in public policies in order to modify large-scale behaviours, based on a complex analysis of social economic and psycho-cultural indicators.

8) the development of a set of algorithms as well as planning functionalities that are to be included in systems of recommendation, aiming to offer personalised content on various online platforms, while insuring data security and confidentiality. All of this will efficiently optimise the costs of time, human and financial resources, by offering a hybrid and innovative recommendation system, personalised according to the needs of the client, and which may work on big data sets, guaranteeing an increased scalability as well as generate optimal results. These systems will focus on:

- i. Real-time analysis of big data (e.g. real-time detection of false news);
- ii. Effective anonymization of sensitive data in the systems;
- iii. Scalable conservation of data confidentiality and adaptability to confidentiality regulations available in the country/region;
- iv. Building of systems that should be sensitive to context;
- v. Using more sources of heterogeneous data for developing a centralised model;
- vi. Automation of phases within the life cycle of data.

9) analysis and prediction studies in the field of political, administrative and communication sciences, which imply a certain degree of inter-disciplinarity, conducted with data from communities and public institutions. These studies will focus on the capture and analysis of collective intelligence, of the human behaviour, respectively, with more specific objectives:

- i. Collection and analysis of data sets of the public institutions (mainly, open data);
- ii. Collection and analysis of large sets of data that are publicly available (using scraping applications and API interrogation) in the online media and on digital platforms – fora and discussion groups, social media, instant messaging platforms – and their analysis from various perspectives (elections, influencing public opinion, commercial, etc.);
- iii. Collaborative labelling of messages (articles, posts, comments, images) from large sets of data;
- iv. Building of prediction models on the basis of certain sets of labelled data. Areas of interest: detection of entities, detection of themes, detection of offensive content, detection of information values, classification of the communication style;
- v. Building co-occurrence maps and other views on the basis of terms and codes (labels applied manually or applied according to certain prediction models).

10) performance of studies in the field of tourism and hospitality in order to support local stakeholders and promote entrepreneurship (Smart tourism strategies, impact studies, revenue management, digitalisation strategies etc.)

3.4. eHealth/tHealth:

The eHealth Centre relates the RDI activities of RDI laboratories/units from a range of diverse fields of specialisation, from mental and behavioural health, psychology, public health and sport to mathematics, physics, biology and engineering, drawing on the strategic infrastructure of UBB.

In the field of mental and behavioural health, the main directions of work integrate the three major scientific approaches that have defined and shaped the field of mental and behavioural health: (1) testing of psychological interventions is done following the models of evidence-based and personalised medicine approaches, which means that the interventions developed are rigorously tested using methodologies that require exclusion of confounding variables and replication of observed effects, such as controlled clinical trials and meta-analytic systematic reviews. In addition, interventions are tailored to the individual's risk profile and underlying factors; (2) identification of the risk profile and determinants is conducted on a multilevel basis, drawing on basic research studies that highlight the genetic, neurobiological, psychological and social factors that cause, facilitate, maintain, etc. the mental health problem or risk behaviour of the individual; (3) in order to ease access to interventions as widely and cost-effectively as possible, i.e. to make them more appealing to their target populations, interventions are delivered using technological tools such as mobile devices, virtual reality, or social robots. As an example, access to scientifically validated interventions is facilitated when they are delivered in a streamlined format using mobile apps, which require only occasional and asynchronous interaction with a specialist, as it reduces the cost of these interventions (compared to a face-to-face consultation) and makes them accessible virtually anywhere. Furthermore, the individual receives the support they need in settings where the specialist would not normally be able to reach them (such as a patient's home). The use of social robots to help teach social skills to children with Autism Spectrum Disorder is an example of how technology (the robot agent) facilitates the intervention because the target population is more easily drawn to these robots and learns by interacting with them. The main lines of scientific development have multiple inter- and trans-disciplinary dimensions, in relation to fields such as biology, by studying the genetic and the neurobiological background, and with regard to public health and physical education, by studying health-relevant behaviours, their underlying psychological factors and the thorough testing of behavioural interventions. The directions identified also involve a close collaboration with information technology specialists and researchers in order to fully exploit the potential of technology to disseminate scientifically validated psychological interventions.

With a view to maintaining and enhancing the national and international competitiveness of the University and its research team along these lines, the strategy we envisage in the field of mental health is guided by the following research directions:

1) implementation of a research programme for the development and testing of innovative psychological interventions in the evidence-based paradigm. In order to develop this direction, we intend to carry out further studies that will draw on the team's potential and expertise, by carrying out programmatic studies that will digitally translate a series of 'classic' face-to-face intervention principles and techniques that already have empirical support available through mobile and online applications and therapeutic games. Such apps will modernise the manner in which interventions are delivered and increase the accessibility of scientifically validated psychological services. On top of the classical principles, derived from well-established paradigms and wherein the research group is already an international standard-setter, as for example it is the case for Rational-Emotive and Behavioural Therapy, we plan to integrate innovative components, derived from mainstream research (e.g. phenotype-based personalisation of interventions) and from newly emerging areas of psychology (e.g. positive psychology). Research will be conducted through randomised controlled clinical trials to ensure widespread uptake of the new services in the scientific community and patient population;

2) conducting baseline research studies for multi-level analysis of factors contributing to the onset of mental disorders. In order to pursue this line of research, we are considering studies in the experimental psychopathology paradigm, paired with neuroimaging and genetic association studies, allowing the detection of psychological and biological factors of relevance to health and disease. Factors that will be identified as showing potential to be altered or to have their incidence reduced will be further targeted by interventions developed in the laboratory, in translational studies, and then piloted within intervention packages in clinical and controlled trials;

3) identifying and developing new technologies for delivering psychological interventions in the treatment of mental disorders. In order to advance this line of research, we envisage undertaking complex, trans-disciplinary projects to determine how emerging technologies, such as virtual/augmented reality and social robots, could be adapted as a tool for healthcare support (e.g. using virtual reality to train cognitive skills). Such tools could then be the subject of studies into their effectiveness to demonstrate their therapeutic potential;

4) dissemination of scientifically validated psychological interventions and testing their effectiveness in professional practice. Our aim is to develop this line of research by conducting studies with high ecological relevance in which we investigate the uptake of scientifically validated procedures in professional practice and test their effectiveness under low-control conditions, i.e. the cost-benefit ratio they generate;

5) development of research infrastructure and capacities refers to concentrating efforts on the long-term upgrading and maintenance of research infrastructure, a key element for competitiveness. We thus envisage actively seeking national and international calls for projects that fund the development of the infrastructure components, as well as making procurements in a planned framework of projects that mainly fund research activities. Last but not least, we are considering constant training of the research team by networking, undertaking projects, and joint programmes with world-leading teams, carrying out academic mobilities, especially for young team members, and recruiting external collaborators to join the extended team as consultants.

In the field of public health, the three following research directions are proposed:

1) the development, implementation and dissemination of sustainable and effective interventions using mobile technology (mHealth) in order to prevent and reduce health risk behaviours, particularly in the maternal and child health sector. This entails two distinct aspects: i) developing and testing the preliminary feasibility and effectiveness of mHealth applications and testing their effectiveness in type II hybrid randomised clinical trials, with a focus on their implementation and uptake in the health system; ii) integrating reinforcement learning artificial intelligence algorithms into the mobile applications

developed, in order to constantly update the intervention content based on user behaviour and user-reported data in the application;

2) the development, implementation and evaluation of eHealth/mHealth solutions to increase the safety and prevention of accidents which constitute the primary cause of death among children and young people and which can be avoided and contained through behavioural and environmental changes, modifications of the surrounding and constructed environment, the implementation of solutions focused on law enforcement and the development of engineering solutions (including IT solutions) at three different points in time: prior to the event (trauma/accident) - primary prevention, during the event - secondary prevention, and after the event - tertiary prevention. Hence, integrating eHealth and mHealth components into formative research and software development in public health can contribute to the prevention of risk factors, increase knowledge and awareness of risk situations, increase access to healthcare and support services;

3) the development and use of e-learning technology platforms in the training of healthcare professionals (e.g. school doctors, community health nurses, health mediators, etc.) with the aim of increasing their skills in areas such as health promotion, health literacy and health communication. These platforms can be advanced in the public sector by local authorities.

In the Human Health sector, the following research directions are proposed by the Faculty of Biology and Geology:

1) development of personalised targeted therapies and follow-up of their therapeutic efficacy - this applied research approach has a strong social impact due to the high therapeutic index of these targeted therapies compared to conventional therapies (more precisely, high therapeutic efficacy and low side effects). The implementation of targeted therapies generates a significant economic impact through lower hospitalisation and social insurance costs. Research will focus on i) management and ii) analysis/processing of biological data through 'omics' analyses - proteomics, transcriptomics or metabolomics to assess the effects of therapies at the cellular/tissue/systemic level). Within this direction, a number of research lines are addressed in medicine (study of viral genomes, pangenomics of pathogenic microbial species, etc.), pharmacology (molecular modelling-assisted drug design).

2) development of modern diagnosis methods - this direction will provide: i) public engagement actions; ii) analysis and training support to genetic laboratories/clinics, companies, biotech institutes/firms; iii) support to SME development (targeting bio-medical software development, biotech, drug development). This line of action is also aimed at developing the *Romanian Population Genome Project* (of particular relevance to medical diagnosis and the development of genomic medicine or 'personalised medicine' applicable to the Romanian population).

In the field of Sport and Physical Therapy the following research directions emerge:

1) curricular and academic physical education - conducting baseline research studies on the state of health analysis of pupils and students, while taking into account the psychosocial environment and genetic background as determinants of physical activity and impact on fitness levels, incidence of cardiovascular disease, inflammatory biomarkers and mental health. In order to achieve this objective, a diagnosis of sedentary and physically active habits and fitness levels in children and young people is essential. This information will provide a better insight into the lifestyle associated with the risk of cardiovascular disease and other phenotypes that are of clinical and public health policy concern;

2) recreational sport (leisure):

i. preferred locations for leisure-time exercise - research following conceptual frameworks for nature related values indicates that the way people perceive the structural and functional elements of their ecosystems can serve as criteria when choosing where to spend their leisure time, and therefore where to engage in physical activities. The findings of the research can be further disseminated to the local, county and regional authorities to help them align a strategy for the development of a leisure-time recreation infrastructure;

ii. selection criteria for performance sport - development of selection strategies and steering children towards performance sport. To this end, close communication networks will be established between the

actors involved in this process in order to enable talent access to infrastructure, experts and optimal resources to develop their athletic potential. To this end, we believe it is necessary to develop a national database, comprising anthropometric data, functional indices, sports branches, performances achieved. That would provide a useful tool for monitoring trends in the development of the young population, which could yield useful information, both in forecasting sports performance and in aligning public health policies;

iii. programmes to raise awareness on the importance of physical activity and promote physical activity among seniors. Development of information and dissemination guidelines to raise awareness among the elderly population on regular exercise in line with WHO recommendations.

Dissemination of informative leaflets to the public, providing them with targeted exercise programmes for the prevention of certain pathologies common to different population groups in specific areas, as identified by studies, highlighting disease patterns in old age;

3) performance sport - development of an infrastructure equipped with dedicated research facilities is essential to boost sports performance to a competitive level by bringing together specialists from relevant fields. Research in performance sport has a wide range of applications, from mathematical and statistical analysis in the assessment of athletic performance, to the scouting of talent and, last but not least, to improved training methods and criteria for the selection or set-up of sports teams. Research in performance sport draws on psychology, biomechanics, physiology, chemistry, nutrition, etc.;

4) prophylactic and therapeutic exercise - recent studies demonstrate the ongoing necessity to develop methods and equipment to support prophylaxis and post-traumatic recovery in performance sport. Therefore, we recommend the development of a multi-purpose academic centre for research and teaching in the field of movement therapy, which will provide continuous training for specialists and also offer outpatient services to the public.

3.5. Digital Art & Humanities (DAH)

DAH puts forward a framework for researching arts literature through computational methods (statistics, big data). This framework strives to align research on Romanian cultural and artistic phenomena with the global academic environment and aims to materialise into a laboratory modelled on the existing laboratories in Western universities over the past decade (Illinois University, Stanford University, for instance).

The transdisciplinary intersections can involve information technology (gamification) and media/radio, film studies, cultural studies, music studies, history, interactive arts to name but a few. The advantages of developing such a framework are primarily linked to the design and operation of software for the analysis of cultural or artistic content (both text and visual material) that generates data networks, research tools and innovative outcomes that are only observable in such macro-economic approaches to cultural and artistic phenomena. A core objective of this framework is to create open source databases similar to the ones that are internationally available (e.g. book archives, fiction archives, music scores, Dacian ceramics, medieval manuscripts, church archives, art objects, etc.). The following lines will be considered:

1) *critical cultural industries studies*: proposes cultural and historical research that explores the organisational, political and economic contexts of cultural production - from books and cultural magazines to theatre, television and cinema. It examines cultural policies, funding sources, organisational practices, marketing, distribution and promotion strategies for the cultural output and its authors; it also looks at the influence of this context on creation, identity and the artistic and cultural output;

2) *storytelling and cultural consumption in the digital age*: offers a reinterpretation of the impact of digital technologies on stage and film production, book production (both fiction and non-fiction), with a focus on the transformative dimensions of storytelling. It also considers matters of distribution and reception, intermediality and transmediality (narratives that develop across multiple media formats) and how they impact consumerism. The research considers the role of digital social networks, online distribution and consumption (including blogs, fan sites and amateur culture and production), algorithms and innovation in the field of digital content generation, and exploitation through digital platforms (film,

TV, books, applied performance arts). A major objective is to develop documentaries and publications in order to disseminate the outcomes of literary, historical, musical, etc. research in an online format, in order to offset the impact of misinformation on particular aspects of Romanian history and culture (false clichés and tropisms);

3) *history, memory, archives and the curation of cultural heritage*: proposes research centred on the archiving of the cultural output and its integration into acts of remembrance, histories, and canons, as well as in the generation of traditions and collective identities. It addresses the politics of processing cultural heritage and legacy, the evolution of these practices over time and their reinterpretation in a European and global context. The intellectual history component - with its visual, anthropological, literary, performance culture components - also constitutes another level of interdisciplinary articulation;

4) *aural and visual humanities*: aims to engage with the international circuit of ideas on the challenges that concepts such as orality, writing, narrative, representation, etc. bring into the contemporary humanities research. More specifically, our proposal is to carry out interdisciplinary research on the oral history of the communist regime, on topics of common concern to the participating faculties: e.g. history of culture - literature, theatre, music during the communist regime, urban/rural history, private life under communism, the events of 1989, the mineriads, the history of minorities, etc. This framework will provide a platform for conducting background research, identifying and contacting key witnesses, creating the interview guide and legal documentation on copyright and personal data protection, conducting oral history interviews, transcribing and archiving oral history interviews, producing academic materials, securing input for the preparation of dissemination materials, creating and managing a database of oral history interviews connected to international networks in the field and involving participation in field work, technical support in the field for video recording and photographic documentation of research surveys, technical processing of interviews, analysis of audio-video recordings, creation of presentation materials (documentaries, podcasts, photo exhibitions, multimedia montage, including augmented reality, contribution to the creation of interview guides, involvement in the field work, analysis of oral narratives from oral history interviews, writing scientific materials, contributing to the translation of research outputs, providing metadata translation into at least English for the oral history database, e-discipline, digitisation of audio/video materials, compiling a musical repertoire of local composers. Following the same model, diachronic research can be conducted on a city, for example, analysing the transformations of the urban space from antiquity to the present day, while using augmented reality; crossover, contemporary history research on, for example, life on the border (allowing for oral history interviews with colleagues from research institutions in Serbia, Bulgaria, Republic of Moldova, Ukraine, Hungary) or, the history of the Danube river from its sources to its estuary (this could be a major interdisciplinary project involving specialists in biology, geography, ethnology, economics).

3.6. Ethics & Sacred Musics (ESM)

ESM proposes a research area that is marked by the following main directions:

1) the inter-religious direction, which seeks the specificities and common elements of the Orthodox, Catholic (Roman-Catholic and Greek-Catholic) and Reformed Theologies, both from the perspective of their individual traditions and sources, and in terms of the present challenges. A special focus will be cast on aspects referring to peacebuilding and coexistence in an inter-cultural, inter-ethnic and inter-religious context;

2) the inter-disciplinary direction, which pursues the dialogue between religion/theology and contemporary sciences both in epistemological terms, and from a knowledge unit perspective. This research sector has found a fertile and generous ground for development within Babeș-Bolyai University (UBB), which has 22 faculties that correspond to the main fields of science. Thus, the School of Divinity will collaborate with the other Academic Schools from UBB;

3) the socio-cultural direction, dedicated to the analysis of contemporary society and culture from a theological and moral perspective. Faculties of Theology train specific cult staff, pastoral and social operators, specialists in sacred art and music, in order to support the mission of their Churches in this rapidly ever-changing society. Therefore, the university training should be supported and updated through

the research of socio-cultural phenomena that contribute to the crystallisation of the mind-set and axiology of the contemporary man.

4) the musical creation direction proposes: i) the artistic creation (classic musical creation and computer-assisted musical creation; creation for stage performance), ii) the musicological research, the music of the 20th-21st centuries (musicological and ethno-musicological research), iii) the cultural mediation (e.g., musical mediation, the kinaesthetic relationship between music and movement in a concert for children).

The concept of cultural mediation finds its best place in the area of musical creation *inter alia* through the inter-cultural and inter-religious potential that is inherent in the domain. Professional musical institutions expand and diversify their educational activities and community commitment tasks not only with the aim of attracting new public segments, but also to enhance their cultural role and relevance in the city they are located and outside.

An essential role in these activities is played by musical mediators who are prepared to build a bridge between music and an audience that is not familiarised with such a musical language. Music faculties can substantially contribute to an increased interest in music among people that do not consider themselves close to classical music. For example, the students from the master programme *Musical Art in a Contemporary Context* will have the necessary training for performing musical mediation activities in different communities in Cluj-Napoca. These activities can be successfully performed with certain social groups such as children and teenagers, on one side, and seniors, on the other side. Partnerships can be concluded with institutions such as kindergartens, elementary schools and after-school programmes, social groups of parishes (there is some form of collaboration with the Hungarian Reformed parishes) and elderly care homes. Depending on the particularities of a social group, small concerts can be organised that would include a dialogue with the audience, participatory activities, as well as presentations on music with recorded auditions.

The research projects that will be performed at the centre are expected to generate some expertise with regard to aspects of methodological development and also: i) a diagnosis referring to the current state of theology, of religiousness and of the dynamic of socio-cultural values; ii) inter-religious, inter-ethnic and inter-cultural mediation; iii) psycho-pastoral counselling; iv) identifying new models for building the dialogue between theology and science, that would meet the current challenges. Therefore, a number of subject matters will be approached such as:

- 1) promoting and encouraging inter-religious musical research, in order to build awareness about the contribution of music to the setting up of a common cultural heritage;
- 2) designing, planning and performance of multi-religious cultural events, for disseminating the musical creation belonging to the national and universal cultural heritage in the public area;
- 3) disseminating aesthetic values generated by music in the public area, with a view to shaping a reflexive attitude toward the role of music both in the life of an individual and of a society as a whole;
- 4) initiating certain scientific research directions concerning the various forms of musical expression of the main Christian traditions, in the context of their social, cultural and artistic history and tradition;
- 5) contributing to community development at a local, regional or national level, through musical actions that are integrated in cultural and educational contexts;
- 6) establishing an inter-cultural and inter-religious dialogue through music as a common language;
- 7) systematic research and capitalising on traditional religious hymns (sung in the lectern) from among the churches:
 - i. collecting as many versions as possible of traditional religious hymns;
 - ii. setting up a digital audio collection including religious hymns, video edits, digital photographs, and other information, that would allow for an effective access to the collected information;
 - iii. performing the transcription and the systematic musicological analysis of some of the collected hymn versions;
 - iv. drafting some presentation materials outlining the research results: studies, scientific communications, monographies, catalogues;

v. introducing certain synthetic data from the research results in the analytical programmes of the theological education institutions.

8) implementing certain educational actions that will lead to the effective learning, build-up and development of knowledge, skills and attitudes specific to the music domain, with the aim of training church singers to perform in choirs and musical activities in parishes.

9) compiling musical repertoires, based on age categories, intended for catechetic programmes with the youth and adults.

10) supplementing the Transylvanian church music repertory by composing new songs intended for the theological schools and church singers.

The research projects that will be conducted through the Centre will apply the theological and inter-disciplinary methodologies specific to each subject matter. At a general level, a few methodological principles will be specified as follows:

- the principle of unity of a person's intellectual experience in the multiplicity of the forms of rationality;

- the principle of autonomy, distinction and complementarity of the different fields of knowledge;

- the principle of the multiple levels of reality;

- the principle of coherence with the methodologies and requirements specific to theology;

- the principle of the critical dialogue expressed by a confrontation between the Christian interpretation of reality and the interpretations given by science;

- the principle of knowledge as a way of supporting and ascertaining human dignity and life;

- the principle of moral responsibility accompanying the technological and scientific progress of the human knowledge and its applicabilities, in particular in the area of bio-ethics, ecology, sustainable development and artificial intelligence.

- the principle of the application of quantitative and qualitative research methods, where such an approach is deemed appropriate.

The Centre has an immense innovation potential by virtue of its inter-religious and inter-disciplinary nature and by the fact that it is grounded in the concrete reality of the contemporary society and culture. The results of the theological research will have applicability in the Romanian churches, on a pastoral level, and in the area of social life. Moreover, the dialogue between theology and science can contribute to identifying certain moral and spiritual solutions to the major problems of humanity. On an academic level, the research will lay the basis for new university programmes and for the development of collaboration with universities and research institutes from abroad.