New Scientific Programs and Projects at the Faculty of Textile Technology University of Zagreb, Zagreb, Croatia

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Survey

The paper gives an overview of new scientific programs and projects at the Faculty of Textile Technology, University of Zagreb, which were developed according to the principles of strategic research plans in the Republic of Croatia and priority goals of the EU. After international reviewing these scientific programs and projects were approved and accepted as the government priority project by the Ministry of Science, Education and Sports of the Republic of Croatia, which is very important at this moment for the inclusion of Croatian scientists into international projects and the utilization of accession funds of the EU. These new scientific programs and projects in the field of textile science and technology will constitute main research directives for the period from 2007 to 2012.

1. Introduction

Faculty of Textile Technology, University of Zagreb, Croatia (www.ttf.hr) is a scientific educational institution educating experts in the undergraduate (B.Sc.), graduate (M.Sc.) and doctoral study (Ph.D.), and specialist master study (Mr. spec.) in the scientific field of textile science.

In line with the Bologna process, besides basic knowledge in the field of technical, economic and information sciences, senior students study programs of specific modules in textile materials, fibers, material testing, textile chemistry and ecology, textile design and management, clothing engineering and technology, industrial design of textiles and clothing.

Education in textile sciences has a longstanding tradition at the University of Zagreb. In 1960 the following departments were founded at the Faculty: Department of Textile Knowledge & Testing and Department of Chemical Textile Technology, and in 1974 Independent Department of Textile Engineering. The independent Faculty of Textile Technology of the University of Zagreb was founded in 1991. A high quality level of scientific work reflected in a large number of published papers, in successful managing and realization of scientific projects and projects for introducing new technologies was an important prerequisite for founding an independent faculty.

Nowadays the Faculty of Textile Technology, University of Zagreb, as a scientific educational institution is one of the leading faculties of this kind in Europe, where scientific activities in the scientific field of textile science are especially stressed. The Faculty employees are included in the work of important scientific associations as members of management bodies of these organizations (AUTEX, DAAAM International, the Textile Institute, ITA, IFKT, AATCC, SDC), and implements a longstanding continuous exchange of scientists within the framework of the CEEPUS program. The Faculty of Textile Technology has also developed an important international collaboration with university centers and scientific institutes worldwide.

The high level of scientific work at the Faculty is based on a high concentration of scientists and modern well-equipped laboratories in the newly built facilities of the Faculty.

The Faculty of Textile Technology is in charge of the organization of the International Textile, Clothing & Design Conference – Magic World of Textiles (ITC&DC, http://itcdc.ttf.hr) which has taken place every second year in Dubrovnik since 2002. A large number of scientists from 32 countries of Europe and the world come to this conference. It has become traditional and is one of the most important European and world conferences on the scientific field of textile and clothing technologies, fashion, design and marketing, and at the same time the only international scientific conference in this field which is held in the Republic of Croatia. In addition, these conferences have become im-

portant international forums where presentations and exchange of knowledge, experiences and results related to new scientific achievements in the field of textile and clothing technology, as well as design and marketing of textile and clothing, and a platform for establishing contacts and international collaboration of the employees of the Faculty of Textile Technology. Next 4th ITC&DC 2008 will be held at the International Centre of Croatian Universities in Dubrovnik, Croatia from October 5th to 8th 2008.

The teaching staff of the Faculty includes 25 full professors, 13 associate professors, 11 assistant professors and 46 scientific assistants and junior researchers who also work within the framework of scientific projects that were accepted after international reviewing by the Ministry of Science, Education and Sports of the Republic of Croatia. In addition, teams of scientists are included into bilateral scientific projects (Austria, Slovenia, and Great Britain) and projects of the EU related to FP 6.

According to the principles of the strategic research plans in the Republic of Croatia and priority goals of the EU new scientific programs and projects in the field of textile science and technology for the period from 2007 to 2012 were created.

After international reviewing these scientific programs and projects were approved and accepted as government priority programs by the relevant ministry, which is very important at this moment for the inclusion of Croatian scientists into international projects and the utilization of accession funds of the EU.

The contemporariness and a high level of the accepted projects are contained in the fact that these accepted projects were published in *International textile and clothing research register* in a special issue of the International Journal of Clothing Science and Technology **19** (2007) 6, 71-109, ISSN 0955-6222, published by Emerald Library, UK.

Besides a high level of research work and scientific activity through the Centre for Development and Transfer of Textile and Clothing Technologies and Fashion Design (CTD), a broad collaboration with the textile and clothing industry in creating projects, drawing up surveys, giving expert opinions and quality testing is expressed.

For the purposes of economy the Faculty of Textile Technology together with the Scientific Council for Technological Development of the Croatian Academy of Sciences and Arts and the Croatian Academy of Engineering organizes the conference **Textile Science and Economy** which will be held in January 26, 2008 in Zagreb (http://tzg.ttf.hr).

More information on all aspects of activities and work at the Faculty of Textile Faculty, University of Zagreb, can be found on the Internet at www.ttf.hr.

2. Scientific program: Multifunctional Materials and Eco-Processes of Textile Finishing and Care

Program manager: Prof. emeritus **Ivo Soljačić**, TTF, Zagreb (e-mail: ivo.soljacic@ttf.hr)

Introducing the innovative processes of textile finishing and care it is possible to obtain multifunction textiles of a higher economical value in accordance with EU regulations for the future of textile and clothing. With the aimed modification of fiber structure and properties it would be possible to produce high performance textiles from waste textiles, recycled PET or Croatian wool and flax, which are not enough used in Croatia. In this respect, the possibility of development of multifunctional protective textiles (UV and EM radiation, resistance to cutting and heat) the processes of textile materials surface modification, emphasizing the new sol/gel procedure as well as coating made of hybrid inorganic-organic polymers will be performed and combined with previous ultrasound, laser and plasma modification. From environmental point of view is necessary to apply biodegradable and non-toxic agents as well as low energy procedures.

Further multifunctional effects are expected from alternative method using microwave energy. Implementation of the method would provide better protection of cellulose materials (textile, wood and paper) against water, microorganisms, flame, dust and UV radiation. The research will focus on the wellness effects in finishing and UV protection during laundering. An accent will be laid on improvement of primary effects in textile care including prevention of environment pollution or poisoning with organic solvents. Analytical methods for determination of heavy metal ions and surfactants on textile materials and waters will be developed with respect to the controlling of toxicological properties. The selection of dyestuff with multifunctional properties, implementation of nano technology in dyeing with the purpose of prevention of wastewater pollution will be of primary interest. Input and output parameters of water, dyes, textiles and their interactions with dyestuffs will be controlled. Models should predict kinetics, affinity, exhausting, fixation, and interaction between different dyes. The methods of descriptive statistics will be applied. Interdisciplinary of dye is the basis for control and adjusting of dyes in dyeing processes and design.

2.1. Scientific project: High performance textile materials and added-value fibres

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Research staff: Prof. Zvonko Dragčević, Ph.D.; Prof. Dubravka

Raffaelli, Ph.D.; Prof. Emira Pezelj, Ph.D.; Assist. Prof. Edita Vujasinović, Ph.D..; M.Sc. Vera Friščić, lecturer; Ružica Šurina, B.Sc.

Project associates: Assoc. Prof. Majda Sfiligoj-Smole, Ph.D. (Slovenia); Zvonko Orehovec, Ph.D. (Slovenia).

Contemporary global trends of development in the field of textile fibres and materials have led to their increased use in various fields of industry and technique. Increase in consumption of these materials has constantly been recorded and at the beginning of the 21st century technical fibres account for half of all the fibres manufactured. The requirements imposed on fibres and materials in particular fields of application are extraordinary high and specific. These requirements have been met through fibre engineering, i.e. development of new fibre's generic types. It can be assumed that innovative production and finishing processes, applied to conventional fibres, will result in their added value, so that they can be used to design new fabrics with targeted end-use properties. Such improvements in fibre properties and their use in fabric of added market value and broader scope of application are completely in accordance with the intentions of the EU technological platform for the future of textile and garment, and it can also strongly stimulate the development of Croatian textile industry and its competitiveness in the global market. This is supported by the fact that there are considerable researches, industrial and raw-material potentials in Croatia, necessary to accomplish the goals. Although domestic production is mostly based on imported fibres, with clearly defined modifications, domestic fibres, such as wool, flax, etc. that haven't been sufficiently used in Croatian textile industry until now, could be used for the manufacture of high-performance textiles. In this manner, domestic fibres would cease being waste and would become strategic Croatian raw material, as well as a basis of future rational management of natural resources and a step in approaching sustainable development trends, recommended by the EU and UN. The investigations proposed aim at establishing the possibilities of modifying conventional fibres, as well as developing the methods and procedures of objective measurement and evaluation of unconventional textile materials, in accordance with specific rules and requirements for individual types of high-performance textiles, including composites reinforced with fibres of modified properties. The results obtained will offer the construction of highperformance materials based on conventional fibres of added value, their design and optimisation in accordance with the properties of the used fibres and targeted high end-use properties.

2.2. Scientific project: Alternative Eco-friendly Processing and Methods of Cellulose Modification

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Project associates: Prof. Christian Schramm (Austria), Ph.D.; Prof. Charles Q. Yang, Ph.D. (USA); Assoc. Prof. Radovan Despot, Ph.D.; Assist. Prof. Branka Lozo, Ph.D.; Assist. Prof. Jelena Trajković, Ph.D.; M.Sc. Božo Tomić.

One of the requests of European Union for higher competitiveness of European market is rebuilding and reconstruction of traditional industrial sectors, especially textile and wood industry. According to the strategical goals of the Republic of Croatia the project emphasizes the use of highly sophisticated production processes and treatments of cellulose materials i.e. obtaining additional and improved characteristics of wooden and paper materials which can be achieved by using high-tech processes and by introduction of nano- micro- and biotechnologies. One of the alternative methods for replacing the conventional reactants containing formaldehyde which were used in textile and wood treatments so far would be the modification with eco-friendly agents such as polycarboxylic acids. Efficiency of these treatments will be determined quantitatively by ester crosslinking analytical methods or by means of isocratic HPLC and spectrophotometric FTIR method. Standard methods of textile, wood and paper material testing would be used for examining their protective performance and resistance to weathering conditions.

Part of the proposed project will be development of optional multifunctional treatment that would provide better protection of cellulose materials against microorganisms, UV, electromagnetic rays, flame, oil or water. Therefore a particular attention will be payed to development and application of the agents which will not only improve the characteristics of textile materials but also give it permanent freshness and provide additional care and protection i.e. medical characteristics. Optimisation of alternative processing and methods will provide ecologically and economically favourable characteristics of treated materials. Further process optimisation in order to improve processing quality could be obtained with new alternative method using microwave energy.

Improved characteristics obtained with this method in our previous research confirm its usability in textile finishing processes as well as in chemical modification of wood. Previous research in this field represents worldwide novelty which should be by all means continued.

2.3. Scientific project: Colours and Dyes in Processes of Ecologically Acceptable Sustainable Development

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Project associates: Assoc. Prof. Marija Gorenšek (Slovenia), Ph.D.; Assist. Prof. Darko Golob, Ph.D. (Slovenia).

Scientific contribution to sustainable development relies on unlimited support of basic, employable and developing research. Therefore, selecting multi-functional dyes (UV and antibacterial protection, multifunctional micro capsules), applying nano-technology in dyeing with the aim of preventing water contamination, developing new methods and purifying dyed wastewaters contributes to sustainable development. Both input and output parameters of water will be controlled throughout the entire dyeing process: amount of residual dye using Lamer-Beer absorption model; X, Y, Z standard spectral characteristics of colour defined by specific absorption coefficient (SAC) and water quality defined by BOD5, COD, TOC, AOX, el. conductivity etc. System of control comprising advanced models such as fuzzy logic (based on rules) and model based on physical and chemical processes will be developed and applied. Capital area of research will involve models of dyeing, colour control and its correlation to dye as well as the interactive system of dye control. Models should describe and predict kinetics, reactivity, affinity, exhaustion, fixation and interaction of solutions containing various dyestuffs. Prediction of output and definition of physical and chemical parameters crucial for controlling the process will be conducted based on afore-mentioned models. These models encompass kinetic models (acc. Nernst and Langmuir) modified for dyestuff/fibre-dyestuff/solution interactions. Interdisciplinarity of dye within the system of sustainable development is based on spectral characteristics of colour as the fundamental model dependent of employment conditions. Instrumental colour measurement is involved in all industrial processes: textile technology, design, graphic industry etc., which enables control implementation and colour harmonization. Application of evolutionary algorithms for modelling computer aided design of textiles based on examinee's subjective evaluation. Methods of descriptive statistics and statistic reasoning will be applied within the frame of statistic analysis. Scientific affirmation will be computer simulation and in vivo confirmation. Results will be publicized in adequate scientific journals and introduced on world congresses. Main goal of the project will be scientific contribution to sustainable development directed towards selection of multi-functional dyes, employment of nano-technology in dyeing processes and colour as a system of communication.

2.4. Scientific project: Multifunctional Human Protective Textile Materials

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Project associates: Assoc. Prof. Vili Bukošek, Ph.D. (Slovenia).

The investigations proposed have been motivated by the fact that people are more and more exposed to various influences from the environment, which can be harmful to their health. Such harmful influences are, for example, UV irradiation, electromagnetic smog, high temperature, fire, etc. Contemporary textile materials for personal protection are required to offer high efficiency, in most cases multifunctionality, as well as a necessary level of comfort. The fabrics used are high-performance ones and interdisciplinary approach is necessary in research dealing with their development and manufacture. The thesis we propose is that the application of contemporary research results in the field of materials can be used to offer a new contribution to the development of multifunctional protective textile materials. The accent will be given to a purposeful surface modification of fabrics, using environmentally friendly agents and processes, which is in accordance with contemporary European trends of research in the field of materials. Special attention will be paid to investigating modifications using the new sol/gel process, combined with preceding ultrasound, laser and plasma treatment of textile surfaces. New possibilities of manufacturing efficient protective layers will be investigated, using various inorganic substances, including functional layers of nano-dimension made of hybrid inorganic-organic polymers. The aim is to optimise modification parameters of achieving efficient protection from UV and EM irradiation, as well as to increase resistance to abrasion, cutting and heat in particular materials, establishing antimicrobial properties at the same time. Adequate testing procedures will be established to evaluate the newly created materials. New levels of knowledge is expected to be achieved regarding correlation of protective properties and textile fabric composition, as well as the development of practical processes of obtaining aimed fabric modifications and the development of the methods of new material evaluation. New knowledge will contribute to the quality of ed-

ucation in the field of textile materials. Transfer of knowledge into actual industrial production is also expected. The results will be presented on international conferences and will be published in relevant international publications. The obtained results to be obtained could be used to stimulate manufacture of new high-performance textile materials for special purposes in Croatia.

2.5. Scientific project: Ethics and Ecology in Textile Finishing and care

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Project associates: Prof. Sonja Šostar-Turk (Slovenia), Ph.D.; Assoc. Prof. Barbara Simončić (Slovenia), Ph.D.; Assist. Prof. Sabina Fijan, Ph.D. (Slovenia).

Modern textile finishing processes have to fulfill high demands due to the expectations of new textile materials properties and their persistence during care. Especially interesting in this respect are the new production processes of socks which include implementation of microcapsules that can release active materials for skin moisturizing. Their primal role is prevention of dryness, dandruff, and allergenic reactions of the skin.

The most suitable analytical methods for determination of durability to washing, friction and sweat will be tested. Durability to washing of products with special properties will be tested with different amounts of anionic and cationic tensides in liquid detergents. The mechanism of adsorption and desorption, their influence on primary effect of the treatment, and the influence of the pH value and the mechanical way of treatment will be tested. On the ground of the obtained results, analytical methods for determination of micro components in the macro components of textile materials should be proposed, without regards to the specifications of the materials or the method of the treatment. The testing will involve a review of the analytical method of each individual analytical procedure as well as its impact on the obtained information. The parameters of the analytical procedure will be worked out with the purpose of restoration of historical textile by destructive and non-destructive methods for the preservation of national heritage.

European controlling methods of new materials have ethical demands involving the human population health which demands an environmental friendly process. For this purpose the processes of textile finishing and care will be optimized. The possibility of obtaining new preventive properties, which were not previously present on the textile material or improvement of present protection, will be tested. The impact of washing cycles with detergent and UV absorber on pastel colored textile materials made of cotton, polyester and their mixtures on UPF and the shade change will be investigated. The quality control of water and effluents will be based on the determination of micro quantities of potential allergens, heavy metals, pesticides, dyes, and tenzides. The traces of solvents will be controlled on the clothing material and in the air during the chemical cleaning and further treatment processing.

3. Scientific program: Anthropometry, Fit and Design of Conventional and Intelligent Clothing

Program manager: Assoc.Prof. **Darko Ujević**, Ph.D., TTF, Zagreb (e-mail: darko.ujevic@ttf.hr)

The program interconnects 4 scientific projects. Based on the results of anthropometric measurements taken, complementary elements of national standards of sizing will be investigated with descriptions, definitions and data for the joint base within the scope of ISO and EN standards, and the development of a computer system for unifying body measurements of garment construction.

Measurements at a total of 4 000 test persons in 5 county centers will be made, with a comparative analysis of specific differences in sporting population in football, water polo, rowing, basketball and handball in relation to the other population, enabling an insight into anthropometric specificities.

Investigation, construction and development of an original intelligent article of clothing by developing an adaptable bed for patients, adaptable ironing machine and measuring instrument for the multiaxial investigation of physical-mechanical properties of technical textile and joined parts will be done. The aim of this investigation is to confirm the possibility of integrating and connecting the operation of sensors and microcomputers with algorithms of intelligent behavior and actuators with independent thermal protection of an article of clothing with active, adaptable and intelligent behavior.

Communication possibilities of intelligent garment with environment will be investigated and an intelligent bed for patients, adaptable ironing machine and instrument for testing stress will be developed.

By investigating the determination of the smallest difference in garment dimension to be perceived, by developing a series of methods of objective interval comparison of garment size and deviation range connected areas and knitwear fit will be brought together.

Several dimension elements will be investigated by using new measuring instruments with experimental investigation of the influence of the effects of garment size and visual design on the perceived body height.

The complexity of problems of sizing pantyhose with investigating different systems of sizing and basic anthropometric data and procedures of fit testing are included into the scope of this program.

Introducing, adapting, developing and using modern numerical methods of analyzing technical problems with the aim of improving the use of engineering methods in the field of textiles and clothing belong to the scope of this program.

Numerical modeling of mechanical behavior of textiles and clothing together with spatial modeling are further methods that will be implemented by creating and developing numerical models suitable for the application.

3.1. Scientific project: Intelligent garment and environment

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Investigations, construction and development of intelligent article of clothing related to its direct environment by developing an adaptable bed, adaptable ironing machine and measuring instrument for multiaxial testing physical-mechanical properties of technical textile and joined parts.

The purpose of the project is that a research team makes researches resulting in a construction and realization of the first intelligent garment whose basic function is active thermal protection. It contains a sensor system for monitoring the values of air temperature inside and outside of the garment, data bus for data transfer, microcomputer and micro controller, and execution devices for the automatic regulation of thermal protection value. Controlling conduction and convection of the heat of the human body regulates thermal protection in such a way that based on anthropometric measurements several types of various air thermo insulation elastic chambers are constructed which are integrated into the construction of the garment between the outer shell and lining.

Thermoinsulation chambers consist of several segments and have a twofold function so that by inflating sealing properties are assumed, and the heat loss of the human body by convection can be regulated and the thickness of the air chambers can be changed by program, whereby the heat loss of the human body by conduction can to be regulated. Micropneumatic elements and the chambers would be equipped with sensors of air pressure integrated into them, because depending on air pressure values in the chambers there will be defined chamber forms, their sealing properties and thickness on which thermal resistance depends. Investigations would prove that the integration and efficient joint operation of the integrated sensors, microcomputers with associated algorithms of intelligent behaviour and actuators so that an independent action of the garment is realized with the aim of thermal protection whereby the garment would have the attribute of active, adaptable and intelligent behaviour in variable temperature conditions.

Communication possibilities of intelligent garment with the environment would be examined and an intelligent sick bed, adaptable ironing-machine and an instrument for testing load would be developed. They would practically use the same or very similar sensor, computer and micropneumatic actuator systems, connection techniques, constructions and design as well as intelligent garment.

3.2. Scientific project: Computational Modelling in Engineering Analysis of Textiles and Garment

Principal investigator: Assist. Prof. **Željko Šomođi**, Ph.D., TTF, Zagreb
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Project associates: Assist. Prof. Simona Jevšnik (Slovenia), Ph.D.; Assist. Prof. Daniela Zavec Pavlinić, Ph.D. (Slovenia).

The intention of this project is to give a contribution to advanced application of the methods of engineering analysis in the field of textiles and garment. This goal will be achieved by introduction, adaptation, elaboration and application of up-to-date computational methods in the analyses of problems relevant for the field of textile and clothing engineering. Considering the existing experience and an overview of questions and problems actual for the engineering science in the field, the research is to be undertaken in a number of areas, such as: optimal design of structural reinforcements in garment based on the finite element analysis; three parameter model of tensile nonlinearity of textiles; computational evaluation of post-buckling stable state in prediction and simulation of fabric drape; general numerical solution of thin plate bending with application to optimal grip geometry in automated work piece manipulation. Depending on the timing and realization of these researches, there is a possibility of opening further research areas from the field of computational modelling in mechanics of textiles and garment, including the spatial modelling and design of clothing items. The methods of research to be applied primarily consist of derivation and elaboration of numerical models suitable for application in the problems under consideration, and the development and

application of computer programmes based on these models. At the same time, the plan is to acquire and apply some of the existing software applicable in the problems to be considered, as well as to prepare and conduct experimental verification of results obtained by computations.

3.3. Scientific project: Anthropometric Measurements and Adaptation of Garment Size System

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Systematic anthropometric surveys have been conducted since 1901 with the aim of developing and improving systems for clothing and footwear sizes. The measurement results show how a national population changes over a period of several decades in physical build and size due to a series of factors (food habits, sports development, genetic predispositions, population migrations, climatic conditions etc.).

Based on the results of anthropometric measurements in the Republic of Croatia (2004/05) on the sample of 30,866 test persons aged between 1 and 82 a statistical analysis of body measurements was performed, a database including 5 basic studies of sex and age as well as a new standard for clothing and footwear was built. These results enable a significant and stimulating continuation of scientific research and a comparison to other national standards and their contributions to the creation of systems for clothing and footwear sizes.

Elements common for national standards of garment sizing by an exact approach will be investigated and analyzed, in particular because the presumptions of national systems and starting elements respectively are not universally founded like intersize intervals which differ in sizes since the conformity of individual starting places is missing.

Data will be provided for a common base with methods of body measuring and size designation of clothes according to the recommendations of the Technical Committee TC133 within ISO and EN standards as well as the design and development of a sophisticated computer system (DOV-KO) for unifying all body measurements and basic garment construction based on one or all other sizes.

Within the scope of this project and based on experience, a very important cycle of anthropometric measurements of the sporting population in football, water polo, rowing, basketball and handball will be performed. 4 000 test persons from Zagreb, Osijek, Rijeka, Split and Dubrovnik will be measured, whereby specific body differences and deformations of muscles caused by longstanding training will be analyzed.

A comparative analysis of the representative sample of the anthropometric measurements of sportsmen and other population as well as the investigation of other trends of body measurements will be performed. This will enable an exceptional insight into the anthropometric dimensions which reflect body shape, proportionality, composition and elements of success in sports respectively.

Stadiometar or a new measuring instrument for continuous measuring body height, foot length and width will be designed too.

4. Scientific program: Mathematical inequalities and applications

Program manager: Academic **Josip Pečarić**, TTF, Zagreb (e-mail: pecaric@hazu.hr)

The proposed program "Mathematical inequalities and applications" represents a natural synthesis of the following five coherent research projects: "General inequalities and applications", "Bounds for functionals on function spaces", "Estimates of sums, integrals and integral transformations", "Convex functions and applications", and "Inequalities and numerical analysis", covering related and complementary topics and research areas in the theory of mathematical inequalities and its applications. The main purpose of this research is to contribute to systematic development of the theory of inequalities and to its integration in the current trends in mathematics. Our aim is to create a competent team of researchers whose relevant results and cooperation with other field experts from Croatia and abroad will contribute to the promotion of the Croatian mathematics in the world. Specific objective of the research is to obtain further progress in exploring the following major research directions: generalizations, refinements and improvements of some classical inequalities; inequalities in more complex abstract algebraic and geometric structures; different notions of convex functions and related inequalities; inequalities in numerical

analysis, especially their applications to numerical integration and interpolation schemes. Beside these four areas, we expect advances concerning some new open problems and research areas related to the subject of the program which will appear during next five years. One of the aims of this program is to give overviews of the obtained research results. We plan to publish at least five monographs with classical results and comparative analysis of results given by members of the program and other scientists researching in the same field of mathematics. All research projects in this research program will share the effort to organize international mathematical conference "Mathematical Inequalities and Applications 2008 (MIA 2008)" (http://mia2008.elemath.com/index.asp). Finally, our aim is to keep and improve relevance and quality of the research journal "Mathematical Inequalities and Applications", the only Croatian mathematical journal on SCIE list. Number of esteemed foreign researchers are taking active part in this program.

4.1. Scientific project: Bounds for sums, integrals and integral transforms

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Project associates: Prof. Lars-Erik Persson, Ph.D. (Sweden); Prof. Shoshana Abramovich, Ph.D. (Israel).

The main aim of the project is to develop some new techniques for estimates of various types of integrals, integral transforms and its discrete analogues and its application to real and complex functions, esspecialy to the various class of special functions. We are planning to obtain: 1. Further generalization and improvements of Hilbert and Hardy-Hilbert type inequalities. 2. Further improvements of some previously obtained Ostrowski type inequalities, trapezoid and midpoint inequalities using Montgomery identity, Bernoulli polynomials and Taylor formula. 3. New versions of Grus type inequalities using Euler identity and Fink identity. 4. Further generalization and extensions of various identities (such as Euler integral and discrete formula, Montgomery integral and discrete identity, etc.) and its applications for improvements of previously obtained inequalities (such as Ostrowski type inequalities, Grus type inequalities, Landau type inequality, Chebyshev inequality, Feng Qi's inequality, etc.). 5. New Ostrowski type integral inequalities involving two functions and their derivatives. 6. Establishing the connection between Euler quadrature formulas and some previously obtained weighted generalizations of Euler identity. 7. Further analysis of some properties of special functions and its integral transforms, with applications especially to the theory of fractional derivatives and integrals. 8. Developing new techniques using possible divergent series in calculation of various fractional integrals and derivatives. Our intention is also to collect the main result obtained by members of our group in the previous projects and the result which we want to obtain in the near future in the form of monographs. In the present time, the project for three of them is already defined: 1. Hilbert inequality and its applications, 2. Gamma functions (Properties, identities, inequalities for gamma and digamma functions), 3. Montgomery's and related identities.

4.2. Scientific project: Convex functions and applications

Principal investigator: Prof. **Marko Matić**, Ph.D., PMF, Split (e-mail: marko.matic@pmfst.hr)

Research staff: Assist. Prof. Milica Klaričić Bakula, Ph.D.; Assist. Prof. Anita Matković, Ph.D.; Senka Banić, M.Sc.; Josipa Barić, M.Sc.

Project associates: Prof. Zsolt Pales, Ph.D. (Hungary); Prof. Edward Neuman, Ph.D. (USA); Prof. Yeol Je Cho, Ph.D. (Korea).

In the proposed project we will investigate convex, generalized convex and related functions, various identities and inequalities valid for such classes of functions, and applications of the obtained results in other areas of mathematics. According to the results obtained so far by the investigators the research will be focused into several interconnected directions. In the first direction we will investigate several classes of generalized convex functions such as functions with nondecreasing increment, P-convex functions, m-convex functions, (a,m)-convex functions, (2r)-convex functions, and functions convex on the soordinates. We will try to obtain variants of Jensen's inequality and related inequalities (e.g. Jensen-Steffensen, Slater, Hadamard, Mercer and other types of inequalities) for these classes of functions. We will be able to use some of the obtained results for proving new variants and generalizations of inequalities among various means, as well as for proving certain new variants of Čebyšev's and Holder's inequality. In the second direction we will study classes of superquadratic functions of one and several variables and their applications to generalizations of various inequalities of Jensen type and related inequalities. In the special case when superquadratic functions are nonnegative, and thus convex, the obtained generalizations will be in fact refinements of known inequalities valid for regular convex functions. This will enable us to improve various estimates which can be obtained by applying these inequalities. In the third direction we will investigate variants of Jensen's inequality for linear functionals and Jensen's ine-

quality for selfadjoint operators, which represent generalizations of Mercer's result, and their refinements. The obtained results will be used for proving monotonicity properties for potential means of Mercer type and its generalizations in terms of quasiarithmetic means. We will also obtain refinements of Jensen-Mercer inequality for index set functions, which will be used to generalize some of the known inequalities between means of Mercer type.

4.3. Scientific project: General inequalities and applications

Principal investigator: Academic **Josip Pečarić**, TTF, Zagreb (e-mail: pecaric@hazu.hr)

Research staff: Assoc. Prof. Vidosava Šimić, Ph.D.; Assoc. Prof. Vera Čuljak, Ph.D.; Assist. Prof. Ana Vukelić, Ph.D.; Jadranka Mićić-Hot, Ph.D.; Sandra Kovač, M.Sc.; Mirna Rodić Lipanović, M.Sc.; Kristina Krulić, prof.

Project associates: Prof. Giampietro Allasia, Ph.D. (Italy); Prof. Wing-Sum Cheung, Ph.D. (Hong Kong); Prof. Leng Gangsong, Ph.D. (China), Prof. Yuki Seo, Ph.D. (Japan).

We expect a significant contribution to world science in theory of inequalities. We will generalize, interpolate, sharpen and improve many general inequalities such as those of Hardy, Holder, Chebishev, Cauchy, Cantorovich, Opialov, Hilbert, Gruss. Also we will investigate and extend inequalities between means and theirs conversions, Jensen's and others inequalities for real convex functions and operator convex functions, variation's inequalities, inequalities in n-normed space, inequalities for simplexes, integral inequalities and other.

4.4. Scientific project: Bounds for functionals on function spaces

Principal investigator: Prof. **Ivan Perić**, Ph.D., PBF, Zagreb (e-mail: iperic@pbf.hr)

Research staff: Prof. Sanja Varošanec, Ph.D.; Assoc. Prof. Aleksandra Čižmešija, Ph.D.,; Assist. Prof. Dijana Ilišević, Ph.D.; Assist. Prof. Rajna Rajić, Ph.D.; Iva Franjić, Ph.D.; M.Sc. Predrag Vuković.

Project associates: Prof. Lars-Erik Persson, Ph.D.(Sweden); Prof. Shoshana Abramovich Ph.D. (Israel).

The proposed research project is a natural continuation of a research under the homonymous research grant no. 037119 during the years 2002 – 2005, which resulted with 26 published papers in relevant international mathematical journals (7 from CC and further 13 from SCIE list). A response to those papers (more than 20 citations in research journals and books) show that the considered topics are interesting and give good arguments to continue our current research. Besides this, during the following period we also want to consider some new interesting open problems and research areas. Objectives of the project are: to prove new identities related to the Chebyshev functional in L^p spaces and to use them to generalize and refine the existing upper and lower bounds for that functional; to explore different forms of the Chebyshev functional and get related bounds for it in modules over proper C* and H* algebras and for p-completely bounded maps in the Banach algebras setting; to prove mixed-means inequalities in L^p spaces of functions on subsets of R^n of different nontrivial geometries and to use them in deriving bounds for Hardy's and the related geometric mean operator, the Hardy-Littlewood maximal function and the Stein spherical maximal function; to define and explore mixed operator power means and Mercer's means; to explore properties of h-convex, superquadratic and other generalized convex functions and to apply them in obtaining new results in the theory of inequalities; to explore different types of function convexity (r-convexity, h-convexity, P-convexity) in more general geometric structures, such as Carnot groups and spaces of non-positive curvature, and to apply them to obtain new results in the theory of inequalities; to get an universal method, based on the Euler identities, for generating quadrature formulae with an arbitrary number of knots, preserving sharp error estimates; to prove some classical inequalities in the Lebesgue spaces with variable exponent; to publish books reviewing the classical and new results on the Gauss-Polya type inequalities, Carleman's inequality and the Chebyshev functional.

4.5. Scientific project: Inequalities and numerical analysis

Principal investigator: Prof. **Nenad Ujević**, Ph.D., PMF, Split (e-mail: ujevic@pmfst.hr)

Research staff: Prof. Ljuban Dedić, Ph.D.; M.Sc. Ambroz Čivljak; Jurica Perić, B.Sc.

Project associates: Prof. Charles E.M. Pearce, Ph.D. (Australia); Prof. Feng Qi, Ph.D. (China).

New results from the fields of mathematical inequalities and numerical analysis will be presented. Specially, we shall consider inequalities in numerical integration, approximation theory, abstract spaces and new quadrature and cubature formulae, new methods in numerical linear algebra and optimization. We shall also consider nonlinear equations.

5. Other projects

5.1. Scientific project: Interface Phenomena of Active Multifunctional Textile Materials

Principal investigator: Prof. **Ana Marija Grancarić**, Ph.D., TTF, Zagreb (e-mail: amgranca@ttf.hr)

This scientific project is being implemented within the framework of the scientific program **Surface Modification in Multifunctional Polymer Systems,** program mana-

ger Prof. **Jasenka Jelenčić**, Ph.D., Faculty of Chemical Engineering and Technology, University of Zagreb, Zagreb, Croatia.

Research staff: Assoc. Prof. Tanja Pušić, Ph.D.; Assist. Prof. Željko Penava, Ph.D.; Anita Tarbuk, M.Sc.; Lea Marković, B.Sc.

Project associates: Assist. Prof. Jasenka Bišćan, Ph.D.; Ivančica Kovaček, Ph.D.; Sonja Bešenski, M.Sc.

Consultants: Prof. Djamal Akbarov, Ph.D. (Uzbekistan); Prof. Emil Chibowski, Ph.D. (Poland); Prof. Edward Rybicki, Ph.D. (Poland); Prof. Eckhard Schollmeyer, Ph.D. (Germany); Prof. M. M. C. G. Warmoeskerken, Ph.D. (Holland).

The goal of the project is synergistic effects of some compounds on modified textile surfaces for achieving multifunctionality of textiles. Interface phenomena of textile surfaces with special accent on surface free energy, zeta potential, electroconductivity, adsorption and desorption of surfactants and other compounds usually used in textile finishing will give a great contribution to multifunctionality of textile. The mechanism of adsorption and desorption of surfactants and other finishing agents on modified textile surfaces is expected to be clarified in the present project.

Different surface modifications, pretreatment and finishing of textile, especially cotton and polyester, will be performed according to European Technology Platform for the future of textile and clothing. For such purpose advance processes like mercerization, cationization, alkali, EDTA, other compounds and enzymes for surface hydrolysis of PET fabric, optical bleaching, implementation of nano antimicrobial active silver ions and mineral delivery mechanism, zeolite and others will be performed. Aminofunctional and other compounds will be added to azalides for the synergistic high antimicrobial effects. In cotton pretreatment enzymatic scouring will be applied using enzymes pectinase and the newest cutinase, for removal of pectins and biopolymers from cotton impurities with lipophylic character, instead of ecologically unfavourable alkali scouring. The goal of the project is synergistic effects of some compounds on modified textile surface.

Interface phenomena of the new textile materials produced from electroconductive, low electro resistance fibres will be investigated for the purpose of static electricity and electromagnetic protection and for its implementation as sensors or other electronic devices in intelligent textiles. Traditional protection and aesthetic role of textile will be spread in active textile multifunctionality. Project will deal with elektrokinetic phenomena (zeta potential, isoelectric point, IEP, point of zero charge, PZC, surface electrical charge, surface free energy), hydrophility and hydrophobilicity, whiteness, fluorescence and phosphorescence, friction, fabric cover factor, elasticity, air and water vapor permeability of textile materials and their protection on UV radiation, microbes and fungi, coldness, heat and flame, static electricity and electromagnetic field.

5.2. Scientific project: Advanced Technical Woven Fabrics and Processes

Principal investigator: Assoc. Prof. **Stana Kovačević**, Ph.D., TTF, Zagreb
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Research staff: Assist. Prof. Andrea Pavetić; Assist. Prof. Željko Penava, Ph.D.; M.Sc. Josip Hađina, lecturer; M.Sc. Valent Strmečki, lecturer; Dubravka Gordoš, M.Sc.; Prof. Biserka Vuljanić; Nikol Margetić, B.Sc.; Ivana Schwarz, B.Sc.; Irena Šabarić, B.Sc.

Project associates: Prof. Vladimir Orešković, Ph.D.; Assoc. Prof. Krste Dimitrovski (Slovenia), Ph.D.; Blago Brkić, Ph.D.; Diana Franulić Šarić, M.Sc.

The subject of this project is advanced technical woven fabrics and processes. They are intended for the use in interior decoration, transportation, industrial and medical purposes, tapestry and the like. These fabrics contain raw materials in common, and domestic wool and linen yarn as well as glass and carbon yarn will be preferred, but other natural raw materials will be used too, yarns of chemical fibers from synthetic polymers and "smart" yarns. The aim of this research is to find the most optimal raw material and fabric construction and to make a commercially acceptable, qualitative, healthy, comfortable and smart technical fabric. Basic investigations will include: physical-mechanical, thermal, relaxation and elongation properties, dimensional stability, abrasion, effect of sun rays, inflammability, air permeability, water repellency, degradation and the investigation of these properties depending on fabric application. The scope of investigation will include technical fabrics intended for use in civil engineering, transportation and household (3D fabrics for composites, fabrics for seat covers, furnishing fabrics etc.) on which high requirements are set, such as: safety, resistance, comfort and aesthetics. Technical fabrics for industrial purposes such as filter fabrics and fabrics for composites which are of great importance for better utilization and productivity, and still more important in terms of ecological protection of environment, will be investigated. Healthy fabrics in medical terms from natural raw, and generally fabrics with various properties and applications subjected to additional treatments according to health standards. Part of the project will be directed at the investigation and revival of Croatian eco and ethno heritage, including the manufacture of tapestry, blankets and mats interwoven with art and skill of weaving, using domestic raw materials. The aim of this research is that tapestry authenticity and originality of work of art

represent a unique value. The significance of this project is to revive the processing of domestic wool and flax in parallel with the investigation of new constructions and forms of glass technical fabrics, and new materials processed by new technologies. Several technical fabrics replicated in this project will serve as an encouragement for processing domestic wool and flax in smaller batches in karts regions of Croatia.

5.3. Scientific project: Ergonomic design of the worker-furniture-enviroment system

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Sitting furniture should enable the worker to take an optimal bodily sitting posture, ensuring active and dynamic sitting. A long-lasting and non-ergonomic bodily posture in this position causes uncomfortable sitting. Defining optimal working postures and strains makes a contribution to the reduction of necessary energy and facilitates working and circulation functions. The total work space should be designed in compliance with all criteria of the working posture and technical requirements. It is necessary to know the worker well, his working capabilities, work place and work methods to ensure an optimal working environment. Furniture dimensions and workplace, surrounding the furniture, regarding its optimal utilization, should be harmonized with the worker's anthropometric sizes. Research methods are experimental, theoretical and numerical. Functional dependences of the worker-furniture-environment system will be investigated, based on ergonomic postulates in order to find optimal conditions between work humanization and productivity. Investigations are determined by measuring and recording typical working postures as well as conditions of excessive workload. Using digitally scanned 3D anthropometric characteristics of the human body, a digital 3D biomechanical model is obtained, taking account of the appropriate kinematic-dynamic motion rules and the construction of the inner skeleton. 3D program applications with advanced automated defined anthropometric and ergonomic features of biomechanical models and digital figures will be recorded. A 3D visualization of the workplace by using a computer-based 3D model of furniture and computer-based character animations of workers will be performed. By using computer 3D program solutions, the prototype is substituted by 3D models on which all necessary designs and changes in real time have been carried out interactively. Computer visualization will be used to perform a biomechanical analysis of movements based on the real correlation within the space of the interaction of workers and belonging working environment on the obtained 3D models of workers and workspace. It is necessary to analyze the workspace and time studies of motion accurately. The 3D virtual model will enable a detailed biomechanical analysis of motion, speed and acceleration and more designer's solutions of furniture with biomechanical and ergonomic parameters. Detrimental impact of too a high noise on workers as well as efficient procedures of noise reduction will be investigated. Special attention will be focused on detrimental action of microclima-tic conditions regarding technological requirements of the industry. The optimization of work energy during the performance of the work by the worker will be performed to lessen fatigue and to remove excessive workload and to reduce sick-leaves. The performance of these investigations will result in ergonomic technical-economic design of the interactive work-furniture-environment system which is of great importance for the development of the Republic of Croatia and elsewhere in the world.

5.4. Scientific project: Multifunctional technical nonwoven and knitted textiles, composites and yarns

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Project associates: Prof. Momir Nikolić, Ph.D. (Slovenia).

Further dislocation of the textile production from developed countries into Asia is a basic characteristic for the world textile industry today. In the field of technical textiles profound resistance is felt against relocation. An increase in the production of technical textiles is recorded due to a permanent expansion of the application range. It is used in: transportation, industry, medicine, hygiene, household, garment industry, agriculture, fishing trade, civil engineering, sport, safety, ecology etc. Nonwovens make the most significant contribution to the development of technical textiles. Over last decades the technology of nonwovens production has experienced a rapid development, and the production of late years has registered an annual increase of approx. 10%. A significant application range for technical textiles or geotextiles is civil engineering, in particular road building. In addition to woven, knitted and similar structures, nonwovens play a predominant role with a share of approx. 75% in 2005. The most important functions of geotextiles are: separa-

tion of weak soil, reinforcement of soil or elements of building structures, filtration and drainage. Geotextile properties are: stability, uniform structure, small thickness, high strength and stretching, porosity, small surface mass and water permeability. Various applications require a more or less marked particular structure and characteristic. The first part of the project will deal with various structures and properties of technical textiles based on nonwoven and knitted structures, in particular on geotextiles. Moreover, manufacturing technologies of technical textiles and knitted materials as well as their controlling parameters will be discussed. Conventional technologies such as: spinning, weaving, knitting and clothing technology will probably not withstand the competitiveness coming from Asia. Besides, relocation of the manufacture of manmade fibres into the Far East is taking place. It is undoubtedly the case that only those disposing of raw materials and enough knowledge to produce and sell high-quality products will have the chances of survival on the market. The investigation of possibilities of manufacturing from coarser sorts of wool which have similar fineness as domestic wool and the investigation of their possible use for products such as carpets and several articles of clothing will be within the scope of this project. The limit of fibre spinnability, typical stress-strain curves, yarn behaviour in cyclic examinations of elongation properties, surface friction and yarn hairiness.

5.5. Scientific project: Design and manufacture of nets for the protection of fruit and vegetables against hail

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Project associates: Krešimir Hajdarović, Ph.D.; Ivan Bašnec, M.Sc.

Approximately 7% of Croatian fruit is present on the Croatian market. The production and sales of Croatian fruit can be quadrupled and sold at present prices on the Croatian market, but as first class fruit. Over the last ten years The Ministry of Finance received damage reports worth more than 100 million kuna which were caused by hail. Fruit, vegetables, plants, flowers, nursery gardens, and animals, material resources: houses, agricultural machinery, automobiles and the like get damaged. Up to now rockets have been used to ensure hail protection of fruit and vegetables.

On account of a rapid increase in the volume of air transport this technique is less used and is substituted by using protection nets. Several more developed and neighbouring European countries have started using nets for the protection of fruit and vegetables against hail. Within the scope of this project systems of applying protection nets in European countries and their use in Croatia would be studied. The emphasis here would be on the safety of orchards, new plants or crops and how to pay compensation for damages by hail. Appropriate protection nets would be designed and manufactured for particular agricultural products and then installed on plantations. Net construction depends on the application so that protection nets of various widths, shapes, colours and structures with special emphasis on the raw material for the production of nets and for shadowing the area to be covered. Across Croatia nets would be offered to the registered fruit growers for use. During the first year of the project a fruit grower would be offered 1000 m^2 of nets without charge with the aim that he buys the same quantity (ratio 1:1) and that he should cover only one part of his plantation. By continuous monitoring orchards all changes under the nets would be analyzed and then compared to the results obtained outside the nets. Over the period of five years relevant conclusions about the use of nets for the protection of fruit and vegetables against hail can be made. It is to be emphasized that the nets, which protect agricultural productsagainst hail, can protect against sun, birds, animals etc. By adequate use of the above mentioned nets it is to expect that yield per hectare will be increased as well as fruit quality. Up to now our fruit growers have collected less than 50% of first class fruit, but using nets it can be expected to increase this limit over 80%. In this way, when Croatia enters into the European Union, we can sell our quality fruits on our market and compete on international markets.