אורט בראודה
ORT Braude College

RESEARCH AT ORT BRAUDE COLLEGE

2016-2018

אורט בראודה
ORT Braude College

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Prof. Arie Maharshak,
President

ORT BRAUDE ACADEMIC COLLEGE OF ENGINEERING

Since its establishment in the early 1990s, ORT Braude Academic College of Engineering (OBC) has positioned itself as one of the leading Israeli institutions for engineering and sciences, well-known for its excellence in both education and research. Having received institutional administrative independence, the College is moving steadily forward in building an autonomous campus in which our students and faculty continue to cultivate higher education and cutting-edge research.

OBC is constantly evolving, taking steps towards expanding the undergraduate and graduate programs by opening new B.Sc. degrees as well as graduate research programs in various engineering fields and mathematics. These programs constitute yet another platform for growth and opportunity for research.

At OBC, our dedication to excellence and high academic standards provides our graduates with the education and skills necessary to meet their personal and professional goals in engineering and in science. By cultivating independent learning, entrepreneurship and critical thinking, we prepare our students to excel as engineers in a rapidly changing technological world. We also invest substantial resources in training and improving teaching methods, and providing student support systems to create an environment that is both nurturing and challenging.

OBC fosters internationalization as part of its comprehensive strategy by placing special focus on student and staff mobility, participation in research and educational programs, and by expanding its local and global networking.

Our principal goal is to continue developing as a leading academic institution. To this end, we remain committed to uncompromising academic excellence and the cultivation of productive and rewarding educational experiences in the training of the next generation of leading engineers and scientists.

OBC confers a Bachelor of Science (B.Sc.) degree in these fields:

- Applied Mathematics
- Biotechnology Engineering
- Electrical and Electronic Engineering
- Industrial Engineering and Management
- Information Systems Engineering
- Mechanical Engineering
- Optical Engineering
- Software Engineering

OBC confers a Master of Science (M.Sc.) degree in these fields:

- Biotechnology Engineering
- Industrial Engineering and Management
- Systems Engineering
- Software Engineering
- Mechanical Engineering

OBC also offers these educational programs:

- Pre-Academic Studies
- Youth Center for Science Enrichment
- Teacher Certification in Science and Technology

Mission

OBC is a higher education institution in the engineering, technology, and related fields, whose goals are to promote

- *Equal opportunities in Israeli society through education and professional training*
- *The productivity of Israeli industry in general, and that of traditional industry in particular*

Vision

To award an outstanding engineering degree in Israel

Values

Our graduates will be multidisciplinary engineers and possess

- A general and professional education that is simultaneously broad-based and in-depth
- The ability and desire for independent study and teamwork
- The ability to adapt knowledge to changing needs
- Critical thinking skills
- Creative, innovative, and entrepreneurial approaches
- Social and environmental awareness

Our faculty members will be

- Teachers for life
- Up-to-date in their professional fields, in addition to possessing a broad education
- Dedicated to the ideal image of the graduate, as detailed above, with the ability to enable their students to attain these goals
- Able and willing to motivate their students, stimulate their curiosity, and create relevant and up-to-date connections
- Active, high-quality researchers participating in significant research projects
- Involved in the college, the environment, and the academic and professional community

Our administrative staff will

- Possess current professional knowledge in addition to a broad-based education
- Leverage the College's infrastructure and systems to the standard required

OBC will

- Be innovative and pioneering in its teaching methods and in the quality of its teaching
- Attract young, motivated faculty members and enthusiastic students
- Promote an academic atmosphere that is equally formal and informal
- Encourage high quality research
- Always retain its pioneering spirit and emphasize teaching quality, even as it grows and develops
- Lead and influence intellectual, cultural and social development both close to home and beyond

Consistent with our vision, research has played an increasingly important role at OBC over the last decade. This publication summarizes the College's research achievements during the three-year period of 2016 to 2018. During this time, permanent and adjunct faculty members have carried out research projects yielding published papers in refereed journals and papers presented at national and international professional conferences. Through their involvement in research and related activities, researchers position themselves in the mainstream of information flow regarding progress in their fields of research. Furthermore, being up-to-date in current developments offers researchers added value and superior academic teaching credentials.

Prof. Sarit Sivan
Vice President for Academic Affairs

VP MESSAGE

As a leading teaching and research institution, ORT Braude College seeks to promote equality in Israeli society through engineering education, and to advance productivity in Israeli industry. The College operates in a competitive and dynamic environment as a result of the high pace of development in the modern era. We aspire to train the engineers of tomorrow to be intellectually minded, alert, proactive, entrepreneurial, visionary, and above all, open-minded, professional team players and life-long learners.

The six student-centered pillars on which ORT Braude College's Engineering Education Program rest are: (i) Adoption of the PBL (problem- or project-based learning) approach in all study programs, providing the student with the range of knowledge and problem-solving skills, essential for every engineer; (ii) Courses reformed according to the ABLE (Active Blended Learning for Engineering) approach, developed from various sources at the College and adapted to the specific goals of engineering education; (iii) Hands-on design projects included in the curricula, emphasizing the balance between theoretical knowledge and professional skills; (iv) Integration of entrepreneurial, industrial, and multi-disciplinary content in the curricula; (v) Intensive training of lecturers to promote engineering education and leadership and to enhance their mentoring attitude; and (vi) Integration of outstanding students as engineering teaching assistants.

Recently, the Council for Higher Education (CHE) and the Planning and Budgeting Committee (PBC) have placed the advancement of innovation and entrepreneurship in higher education as one of the goals of the multi-year program for the years 2017-2022. For this purpose, the combined proposal of our College, together with the University of Haifa and the College of Education of Tel-Hai, "i-North", was allocated a sum of two million NIS for the years 2019-2022 to support the promotion of entrepreneurship and innovation in these institutions.

The College was further awarded 100,000 NIS by the PBC and the CHE for a unique program developed by the Center for Teaching and Learning for the integration of essential skills in all programs at the College.

The College promotes and supports individual and interdisciplinary research among faculty. There are endless opportunities for the creative and curious mind, from robotics to design, from optics to image processing, and in many other fields.

I am proud to report that since 2016, our researchers have been awarded some of the most prestigious grants, including the Israel Science Foundation (ISF), BARD, HORIZON 2020, Ministry of Agriculture, Ministry of Science & Technology (MOST), the National Institute of Psychobiology in Israel (NIPI), and the Binational Science Foundation (BSF) with the USA and China.

The College is actively encouraging its researchers to expand the scope of their research; the dramatic improvement in recent years of our research facilities provides our researchers with access to labs equipped with a wide variety of state-of-the-art instruments and experimental systems. Our researchers publish widely, including books and articles in leading journals, and present their work at conferences at home and abroad with the College's full support.

The College is fully committed to promoting a stimulating and supportive environment in which students and faculty can excel and achieve their academic and professional goals.

RESEARCH CENTERS

RESEARCH AUTHORITY

The Research Authority was established in 2010 to encourage, support, promote and monitor the research activities of the academic staff at OBC as well as to serve as a scientific, administrative and management framework for research activities at the college.

The activities of the Research Authority include:

- Location, collection, accumulation and dissemination of information about external sources of funding, including government ministries, the Israel Science Foundation (ISF), European programs (FP7), bilateral programs (GIF, BSF) and other funding agencies.
- Guidance and administrative services in submitting research proposals to funding agencies, including advice and support in preparation of budgets for research proposals.
- Provision of financial support for editing grant proposals.
- Assistance in matching OBC researchers with funding sources.
- Assistance in finding research partners and creating consortium or partnership agreements.
- Negotiation with agencies that fund the grant and sign the contracts.
- Financial and administrative management of grants and contracts of funded projects.
- Initiation of research contracts between OBC scientists and researchers at other universities, both in Israel and abroad.
- Initiation and organization of workshops concerning external funding for information transfer and improving researchers' ability to write competitive grants.

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DATA MINING INSTITUTE

The mission of the Data Mining Institute is to utilize the expertise and research of the Department of Software Engineering at ORT Braude College to discover and invent novel and powerful tools for extracting knowledge and solving scientific, business and economic problems. Current internships cover the following fields: heuristic approaches to search networks consistent with experimental data, within the framework of the FP7 grant "New Algorithms for Host Pathogen Systems Biology"; optimization of technical service schedules, under the auspices of the ASTEA International Inc.; and an investigation of user activities, as part of an agreement with the Paris branch of ORANCE. The Institute carries out many studies in the fields of cluster validation, graph clustering and application of machine learning methodology to software engineering problems.

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THE GALILEE RESEARCH CENTER FOR APPLIED MATHEMATICS

The Galilee Research Center for Applied Mathematics (GRCAM) was established by the Department of Mathematics at ORT Braude College in 2005. Its main aim is supporting the research activities of its faculty members through scientific collaborations, as well as the promotion of common projects with engineering departments and industry. The center has organized and hosted over 25 conferences and workshops since its establishment. We strongly believe that research of a high standard is crucial for maintaining excellence in teaching, in addition to its contribution to the reputation of ORT Braude College as an academic center.

The center maintains ongoing cooperation with universities in Israel and abroad, including among others, the University of Rome Tor Vergata, Royal Institute of Technology in Stockholm, University of California Berkeley, University of South Florida, Max Planck Institute Leipzig, Fraunhofer Institute for Industrial Mathematics, Technical University of Kaiserslautern, and the University of Innsbruck.The center has supported visits of mathematicians from various universities, generating a lively and fruitful exchange of ideas. These activities have led to publications in high ranked scientific journals.

The research fields we are engaged in include: complex analysis, dynamical system, geometry and its applications, partial differential equations and applications to natural sciences, optimization, Lie algebra, group theory and mathematical education. The center promotes the use of mathematical models in industry.

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PLASTICS INSTITUTE – ORT BRAUDE COLLEGE

The goal of the Plastics Institute is to provide R&D services for the plastics industry, focusing on:

- Experimental research
- Computer modeling of processes and materials
- Consultancy services
- Courses for the industry in a variety of R&D topics, in factories or at the College.

The institute is located at ORT Braude College, at the heart of Israel's plastics industry.

The institute works alongside the College's commercialization and implementation company, Ofek Eshkolot Research and Development Ltd. The company directs faculty members towards useful R&D, creation of intellectual property (patent writing), and facilitation of business cooperation with industry.

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TEACHING AND LEARNING CENTER RESEARCH ACTIVITY

The Teaching & Learning Center (TLC) was established in 2004 in conjunction with the College's strategy of promoting student learning and thinking skills, lowering first-year dropout rates, and enhancing excellence in teaching.

TLC programs include required courses for all freshmen students, designed to promote learning and thinking skills. The Center also provides small group, peer-led workshops run by high-achieving students, in a collaborative problem-solving setting, a program for supporting underachieving students, and personal academic coaching given by trained College lecturers for students with unsatisfactory academic learning habits.

TLC also offer courses to lecturers. The programs are intended to enhance lecturers' instruction methods and include a process for orientation and support of new lecturers.

TLC's main programs are continually studied in order to assess their effectiveness and provide recommendations for future application and development. We strive to uncover where students are having difficulties and possible reasons for failures, as well as determine faculty needs regarding teaching enhancement. The research data is drawn from the performance of participating students as well as from the perceptions of students and lecturers regarding the programs' contribution.

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OFEK ESHKOLOT RESEARCH AND DEVELOPMENT LTD.

ORT Braude Academic College of Engineering established Ofek Eshkolot Research and Development Ltd. to encourage research conducted at the College. The aims are to expand ties with industry and to promote patents and licensing. The company acts as the College's business arm, leveraging knowledge assets and stimulating advanced industrial development in the Galilee.

From a business perspective, the company commercializes the intellectual property (IP) developed by College faculty members, students, and College employees by licensing or partnering with a strategic partner.

Company goals:

- Directing staff research towards useful research and development (R&D)
- Creating intellectual property that can be commercialized, and patenting R&D products
- Obtaining patents and licensing
- Establishing partnership ventures with investors on the basis of the IP created

The company contracts research projects with industrial and commercial entities, which are then executed by faculty members, adjunct faculty, students, or professional experts whom the company recruits according to need.

For more information, please contact:
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CENTER FOR ENTREPRENEURSHIP AND INNOVATION

The Entrepreneurship and Innovation Center at ORT Braude Academic College of Engineering invites innovators from the College (students, staff members and administrative employees) and external entrepreneurs to use the services offered by the Center to help them develop their entrepreneurial skills and capabilities and realize their ideas as marketable products or services.
The Center is a multidisciplinary education hub, allowing students from different fields of engineering to experience the entrepreneurial process while providing them with nurturing business guidance. The Center works alongside the College's commercialization and implementation arm, Ofek Eshkolot Research and Development Ltd.
Goals:

- Encouraging students, alumni, staff members, and entrepreneurs to strengthen their entrepreneurial orientation and capabilities and launch their ventures.
- Creating an academic platform that allows participants to experience the process and components of entrepreneurship, present their ideas to investors, and participate in competitions.
- Promoting ideas and early-stage startups to successful ventures through the business marketing environment provided by the Galilee Accelerator.
- Continuing the commercialization process through Ofek Eshkolot Research and Development Ltd.

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THE MANUFACTURING TECHNOLOGY RESEARCH CENTER (MTRC)

The mission of the Manufacturing Technology Research Center (MTRC) at the Mechanical Engineering Department of ORT Braude College is to act as a focal point for research and development of various manufacturing technologies, emphasizing machining processes such as turning, milling and drilling. The Center develops capabilities and expertise in the field of manufacturing processes, making it a national hub for research and industrial knowledge. The Center's objectives are to collaborate with industrial companies that develop machining tools or employ different manufacturing technologies. MTRC offers its services and collaborates in research and industrial projects in the areas of wear and life of machining tools, surface finishing of tools and workpieces, conventional and vibration-assisted drilling, monitoring of drilling processes by acoustic emission sensors, numerical modeling, dental drilling processes, metallurgy of tools and materials and friction stir welding. The equipment available at the Center includes two CNC milling machines, a CNC lathe, computer workstations with optical microscopes for measuring wear and failure characterization, sensors for measuring forces and vibrations, and software for numerical modeling and analysis of various metal cutting processes, including COMSOL, ANSYS and DEFORM. The Center works with faculty and adjunct lecturers in the Department of Mechanical Engineering who are expert researchers in the field.

In addition, some projects that graduate and undergraduate students of the Department are conducting are also included in the Center's research activities.

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CRANET - CRANFIELD NETWORK ON COMPARATIVE HUMAN RESOURCE MANAGEMENT

Cranet is an established group of top business schools and academic institutions that collaborate to provide unique and rigorous data on human resource management practices worldwide. Cranet provides a coherent and accurate picture of international and comparative Human Resource Management (HRM). To date, 40 countries around the world have joined the project. The Centre for European Human Resource Management at the Cranfield School of Management (UK) coordinates this collaboration of universities and business schools in the participating countries.
In Israel, Dr. Hilla Peretz of the Department of Industrial Engineering and Management, ORT Braude College, directs Cranet. Additional information and reports are available at our website:
http://www.braude.ac.il/research_and_development/cranet/

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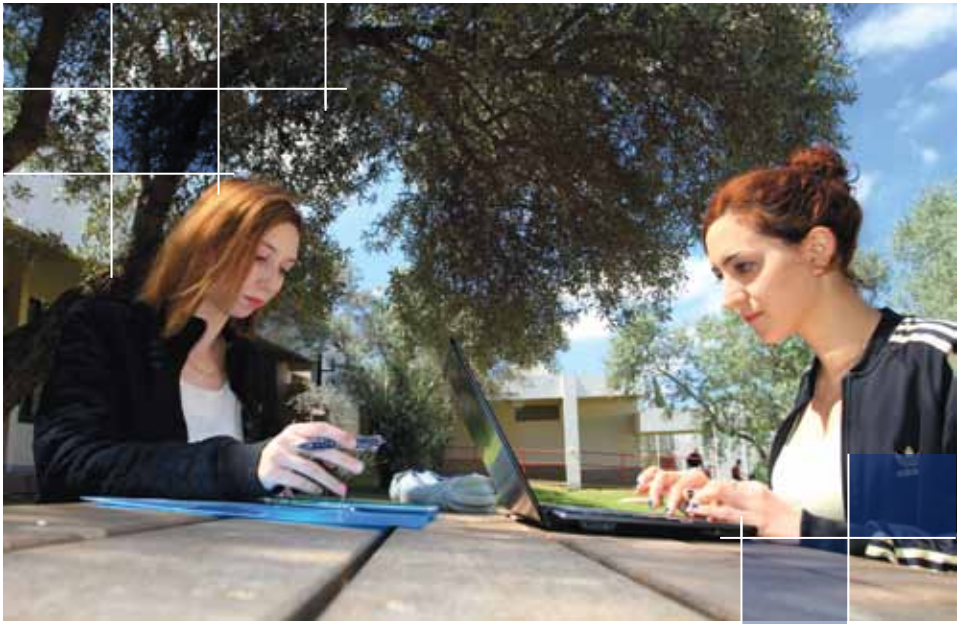

COLLEGE CONFERENCES AND WORKSHOPS

CONFERENCES

Industry-Academia Day
Karmiel, Israel, December, 2018
https://w3.braude.ac.il/event/industry-academy-day/

A joint conference on "Lie groups, Lie algebras and applications"
Karmiel, Israel, November, 2018
https://w3.braude.ac.il/event/a-joint-conference-on-lie-groups-lie-algebras-and-applications/

The 14th Interdisciplinary Research Conference
Kfar-Blum, Israel; October, 2018
https://w3.braude.ac.il/event/the-14th-interdisciplinary-research-conference/

Community-oriented Engineering Conference
Karmiel, Israel; June, 2018
https://w3.braude.ac.il/event/כנס-הנדסה-מוכוונת-קהילה/

The 10th Northern Quality Conference
Karmiel, Israel; May, 2018
https://w3.braude.ac.il/event/kenes_tza-copy/

The 8th Industry-Academia Conference: Multidisciplinary and Interdisciplinary as Development Leverage for Industry and Academia
Karmiel, Israel; April, 2018
https://w3.braude.ac.il/event/כנס-תעשייה-אקדמיה-השנתי-השמיני/

The 13th Interdisciplinary Research Conference
Nahsholim, Israel; October, 2017
https://w3.braude.ac.il/event/conference-research13/

Industrial Day
Karmiel, Israel; October, 2017
https://w3.braude.ac.il/event/conference-research13/

The First Israeli Modelling Week
Nahariya, Israel; July, 2017
https://w3.braude.ac.il/event/conference-modelling_week2017/

Initiatives to Promote Learning in Higher Education
Karmiel, Israel; May, 2017
https://w3.braude.ac.il/event/conference-promote_learning_in_higher_education2017/

The 7th Industry-Academia Conference: Multidisciplinary and Interdisciplinary as Development Leverage for Industry and Academia
Karmiel, Israel; March, 2017
https://w3.braude.ac.il/event/conference-industry_academia2017/

The 12th ORT Braude College Interdisciplinary Research Conference
Hagoshrim, Israel; September, 2016
https://w3.braude.ac.il/event/conference-research12/

The 9th Quality Conference in the Galilee "Quality - Halacha and Practice"
Karmiel, Israel; June, 2016
https://w3.braude.ac.il/event/conference-quality2016/

The 6th Industry-Academia Conference: Multidisciplinary and Interdisciplinary as Development Leverage for Industry and Academia
Karmiel, Israel; March, 2016
https://w3.braude.ac.il/event/conference-industry_academia2016/

WORKSHOPS

Workshop on "Geometry and its Applications"
Karmiel, Israel; December, 2018
https://w3.braude.ac.il/event/a-workshop-on-geometry-and-its-applications/

Workshop on Mathematical Education in Science and Technology
Karmiel, Israel; February, 2018
https://w3.braude.ac.il/event/workshop-on-mathematical-education-in-science-and-technology/

The 20th Israeli Mini-Workshop in Applied and Computational Mathematics
Karmiel, Israel; December, 2017
https://w3.braude.ac.il/event/mini_workshop2017/

Workshop on Operator Theory and Applications
Karmiel, Israel; September, 2016
https://w3.braude.ac.il/event/workshop_on_operator_theory_and_applications2016/

Workshop on Mathematical Education in Science and Technology
June, 2016
https://w3.braude.ac.il/event/workshop_mathematical_education2016/

Prof. Ephraim Katzir Department of Biotechnology Engineering

Prof. Isam Sabbah, D.Sc.
Head of Department

RESEARCH AREAS

INVESTIGATING THE OXIDATION PROCESS AND FACTORS THAT AFFECT THE FORMATION OF OXIDIZED LIPIDS (OXYLIPINS) IN OLIVE OIL

Amal Rouhana-Toubi and **Ameer Taha** (UC Davis – California)

Unsaturated fatty acids that exist in vegetable oils are of great nutritional importance, yet they may undergo chemical oxidation processes and enzymatic degradation that may affect their nutritional value and cause the formation of toxic metabolites. Enzymatic processes occur mainly in the early stages of production, while chemical processes occur during the storage of the oil. It is, therefore, important to monitor the process of oxidation and the development of oxygenated compounds throughout the production stages and under various storage conditions. It is known that oxidation reactions are especially accelerated in the presence of oxygen and at exposure to light and high heat, while the presence of natural antioxidants may inhibit the oxidation processes. By tracking biochemical processes that occur in oil during the production stages and under various storage conditions, we seek to identify the critical steps that are responsible for the creation of oxidized compounds and the critical factors affecting the oxidation development process. The use of advanced analytical methods (GC-MS and LC-MS) allows us to accurately identify minor changes in molecular structures of oil and monitor oil oxidation processes that occur throughout the various stages.

Keywords: Olive oil, unsaturated fatty acids, oxygenated compounds

EXTRACTION OF ANTICANCER AGENTS FROM MEDICINAL MUSHROOMS

Amal Rouhana-Toubi, **Solomon P. Wasser** (University of Haifa), and **Fuad Fares** (University of Haifa)

Cancer is a major public health problem, with ovarian cancer being one of the most lethal tumors of the female genital tract. Medical treatment of ovarian carcinoma has limited efficacy and is often accompanied by harmful side effects. Medicinal mushrooms, known to be a potential source of anti-cancer substances, were selected for investigation in the current research work.

We began our investigation by conducting a screening test to find the mushroom species that were most active in combatting ovarian cancer cells. The screened mushroom strains were extracted with different organic solvents, and their ability to reduce the viability of human ovarian cancer cells was examined in vitro. The ethyl acetate extract of Coprinuscomatus fruit bodies was fractionated, and its active fraction was used in further investigations. Several biological tests demonstrated that the Coprinuscomatus active fraction (CCFB-AF) induces apoptosis in three different ovarian cancer cells. Analysis revealed that CCFB-AF induced apoptosis in ovarian cancer cells via both extrinsic and intrinsic pathways. The fingerprint of the CCFB-AF composition was assembled by GC-MS, LC-MS, and LC-UV techniques. Analysis revealed that CCFB-AF is a mixture of different compounds, some of which were identified by GC-MS. More analysis is needed to completely identify the active components.

Keywords: Coprinuscomatus, medicinal mushrooms, ovarian cancer, apoptosis

MOLECULAR MODELING OF ENZYME-CATALYZED POLYMERIZATION

Dafna Knani

Enzymatic polymerization could be used to prepare bio-like polymers, and especially, optically active bio-like polymers. This research investigates enzymatic polymerization characteristics using computational tools, focusing on enzyme-catalyzed polymerization of polyesters. I have been studying several linear and substituted hydroxyesters with a docking procedure using GOLD (Genetic Optimization for Ligand Docking) protein-ligand software, developed by CCDC (The Cambridge Crystallographic Data Centre). I also study the enzyme-catalyzed ring-opening-polymerization of lactones in silico. In this research, the catalytic ability of several enzymes is explored, looking for their ring-opening polymerization of lactones. The calculations are compared to experimental research results obtained by myself and other researchers. Understanding these parameters can help predict the best conditions for enzyme catalysis.

Keywords: Molecular modeling, enzymatic polymerization, ligand-protein docking, biomaterials

MOLECULAR MODELING OF POLYMERS AND BIOPOLYMERS

Dafna Knani

Molecular modeling study of CO_2 plasticization and sorption onto absorbable polyesters

Computational tools were applied to estimate the plasticizing effect of CO_2 and to calculate CO_2 and H_2O loading capacities for three absorbable polyesters: polycaprolactone (PCL) and

two copolymers of (poly-D,L-lactid-co-glycolid)-co-polyethylenglycol. Plasticization caused by CO_2 was estimated by solubility parameter and radial distribution function at several CO_2 concentrations and by enlargement of free volume detected by mean square displacement of helium atoms, calculated after dynamic simulation. It was found that the maximal value of the solubility parameter and density can serve as a tool to predict saturation concentration. The loading capacity of the biopolymers that were preloaded with CO_2 molecules was significantly higher than the non-treated polymers. Similar results were obtained for H_2O molecule loading.

Simulation of novel soy protein-based structures for tissue regeneration applications

Soy protein-based porous blends, for possible use as new scaffolds in tissue engineering applications, were studied by dynamic simulation. Gelatin (protein) and alginate (polysaccharides) were attached to soy protein isolates (SPI). The structure of the soy protein was downloaded from the Protein Data Base (PDB). According to the calculations, it seems that the strong ionic interactions of the alginate chain make it difficult for the water molecules to penetrate between the chains. In contrast, the gelatin chain is more accessible to the water molecules. This observation might be the reason for the difference in the degradation rate of the two conjugates, the soy protein–gelatin degradation being faster.

Simulation of the bioadhesive gelatin-alginate conjugate loaded with antibiotic drugs

In this research, molecular modeling methods were used to study a novel bioadhesive comprised of gelatin (protein) and alginate (polysaccharides), chemically cross-linked with N-(3-Dimethylaminopropyl)-N′-ethylcarbodiimide hydrochloride (EDC) and N-hydroxysuccinimide (NHS). Three antibiotic drugs were added to the bioadhesive: Vancomycin, Ofloxacin, and Clindamycin. Computational tools were applied to estimate the crosslinking degree and compare the effect of the antibiotics on the mechanical properties of the gelatin-alginate conjugate.

In silico study of the self-assembly and gelation of sugar derivatives

Low molecular weight gelators are molecules capable of forming gels in which they are self-assembled into a physical 3D network of fibers, held together by noncovalent interactions like hydrogen bonds, van der Waals forces, and π–π-interactions. The organic gelator 1,3(R):2,4(S)-dibenzylidene-D-sorbitol (DBS) self-organizes to form a 3-D network at relatively low concentrations in a variety of nonpolar organic solvents and polymer melt. DBS could be transformed into a hydrogelator by introduction of hydrophilic groups, which facilitate its self-assembly in aqueous medium. In this work, the self-assembly of DBS and its derivatives was investigated by molecular modeling, in both polypropylene and aqueous media.

Determination of plasticizer efficiency for nylon by molecular modeling

Plasticizer efficiency is known to be greatly influenced by the structural effects of the plasticizer and the nature of the polymer. In this research, these factors are explored. Based on preliminary results, a homology series of plasticizers has been examined, for example, esters

of 4-hydroxybenzoate, with various chain lengths of the alcohol moiety. Further, the efficiency of linear plasticizers has been compared to that of branched plasticizers and between-stereoisomer plasticizers.

In silico study of self- and co-assembly of Amphiphilic Peptides

Amphiphilic Peptides (PAs) are a class of molecules that combine structural features of amphiphilic surfactants with biological activity. The self-assembling of PAs shows great promise in the development of novel materials. The purpose of this study was to investigate, using computational simulation, the characteristics of different amphiphilic peptides with various quantitative ratio between valine and alanine, charged or uncharged, as pure materials and in combination with the hydrogelator 1,3 (R): 2,4 (S) -dibenzylidene- D-sorbitol-dicarboxylic acid (DBS-COOH) in fixed and variable quantitative ratio and in aqueous environment.

Simulation of a synthetic hydrogel that mimics proteoglycans in the cartilage

Proteoglycan is a protein modified by sugars located in the cartilage nucleus. The goals of this project were to investigate by computational simulation a synthetic hydrogel system that mimics the proteoglycans' function in the cartilage (Biomimetic system) and compare it to the natural system (chondroitin sulphate). The effect of the crosslinking density of the Biomimetic system on its interaction with water was examined.

Additional research projects:

- Investigation of peroxide crosslinking of styrene-free unsaturated polyester alkyd
- A study of fire-retardant blooming in HIPS by molecular modeling
- Prediction of environmental stress cracking in polycarbonate by molecular modeling
- Analysis of the migration of POSS-based nanocomposites in polypropylene by molecular modeling
- Computational study of the interaction of carbon nanotubes (CNTs) with various molecules that may serve as surfactants used for improving CNT dispersion in aqueous media
- Molecular modeling of charged biopolymer interactions. The interactions between two biopolymers, gelatin (positively charged), and chondroitin sulphate (negatively charged), in aqueous media were investigated
- Simulation of the bilayer system based on neutral and cationic lipids in combination with fluorescent lipids
- Investigation of enzymatic polymerization characteristics using computational tools, focusing on enzyme-catalyzed polymerization of polyesters

Keywords: Nanochemistry, multifunctional nanomaterials, medicinal chemistry

ETHICAL IMPLICATIONS OF INNOVATIVE (BIO)-TECHNOLOGIES – DIGITAL PILLS AS AN EXAMPLE

Ilana Kepten

In September 2015, the FDA accepted the first new drug application (NDA) for a digital medicine product. The product is an original combination of a drug (Abilify, an approved drug to treat schizophrenia) and a signal generating ingestible device (the Proteus Digital Health Ingestible Sensor) encapsulated into a single pill. Upon reaching human stomach acidity conditions, the pill simultaneously supplies the medication and generates a signal that attests to the patient's intake of the drug. A patch worn by the patient and a "smartphone" facilitate immediate information transfer to a faraway recipient.

The combination pill potentially promotes patient's adherence to pharmaceutical treatment as well as simplifying clinical trials with new drugs. In addition, users of the digital pill will generate data that would help physicians and pharmaceutical companies better monitor patient behavior. Nevertheless, this data collection method could lead to ethical difficulties that must be considered before future products are widely approved. To initiate such a discussion, we designed a hypothetically enhanced product. Based on the literature, we propose an advanced wearable patch as a collection tool, and an ingestible device that signals multiple times per intake. Such an imaginative yet plausible prototype will generate continuous, multi-parametric (physiological, behavioral etc.) data from each patient with every pill ingested. Such a large body of information highlights the ethical and regulatory issues of information ownership, privacy, medical confidentiality, etc.

This hypothetical continuous data-generating product also underscores challenges to some of the very basic, bio-ethical concepts we currently hold. These challenges should be discussed by all the stakeholders before the emergence of the next generation of digital medicine products.

Keywords: Innovative technologies, bioethics, digital pill

DESIGN AND MANIPULATIONS OF NANOPARTICLES

DESIGN OF NANOPARTICLES FOR THERAPEUTIC AND DIAGNOSTIC APPLICATIONS

Iris S. Weitz

Functionalized nanoparticulate systems are used for a variety of medical and pharmaceutical applications as they are mainly considered ideal carriers for drug delivery and diagnostic agents. ORT Braude College's Department of Biotechnology Engineering's research laboratory combines broad-based knowledge of synthetic organic chemistry with nanotechnology tools to manipulate materials and their properties at the nanoscale level for therapeutic purposes.

Current research activities:

i. Design and synthesis of contrast enhancing materials (CEM) for dual-modality imaging based on copper oxide nanoparticles and gold-copper alloy nanoparticles. This research has the potential to influence a variety of fields, including early cancer detection, leading to a new class of multifunctional nanoparticles.

ii. Study of different drug encapsulation strategies that will trigger a localized release of copper-based nanoparticles by focused ultrasound beam.
iii. Treatment of candida infections by combination therapy of two drugs with different mechanism actions (i.e., copper oxide nanoparticles and small bioactive-organic molecules) as an important strategy in the management of difficult-to-treat fungal infections.

Keywords: Nanochemistry, multifunctional nanomaterials, medicinal chemistry

STRATEGIES FOR NANOENCAPSULATION OF DRUG-CONJUGATED-COPPER OXIDE IN PLGA FOR IMAGING AND CONTROLLED DELIVERY

Iris S. Weitz and **Sarit Sivan**

Biodegradable polymeric nanocarriers such as poly-lactic-co-glycolic acid (PLGA) are widely used as packing material for controlled delivery of drugs and for extending their circulation time. Our main goal is to produce PLGA capsules containing drug conjugated CuO nanoparticles for imaging and drug delivery purposes. This copolymer can both protect the drug particulates and release them in a timed and sustained manner according to the polymer biodegradation pattern. The capability of such vehicles to serve as imaging tools and to affect cancer cells is studied.

Keywords: Drug delivery, polymers, cancer, nanoparticles, emulsion, ultrasound, MRI

EFFECT OF NANOPARTICLES ON HYPERCHOLESTEROLEMIA

Maria Grozovski and **Iris S. Weitz**

Hypercholesterolemia is a condition characterized by high levels of cholesterol in the blood that can cause plaque to form and build up, leading to blockages in the arteries that increase the risk of heart attack, stroke, circulation problems, and death. Dietary lowering of cholesterol has very little effect on cholesterol levels. The use of statins, a family of drugs that inhibit HMG CoA reductase involved in biosynthesis, can help lower blood cholesterol. Statins, however, may also have side effects such as elevation of liver enzymes, gastrointestinal effects, headaches, and muscle pains.
Our group has developed an experimental model of hypercholesterolemia in rats. The current research model is being used to develop a novel methodology of nanoparticle-based drug delivery to overcome the problems associated with statin drugs. Water soluble NPs are used for direct functionalization with pravastatin by self-assembly. The functionalized colloidal systems are characterized by such methods as UV spectroscopy and Cryogenic Transmission Electron Microscopy (TEM).
The research evaluates the following parameters: liver histology, hepatic and plasma lipid content, antioxidant levels, oxidative stress parameters, toxicology tests such as alkaline phosphatase (ALP), aspartate aminotransferase (AST), alanine aminotransferase (ALT) and gamma-glutamyltransferase (GGT), heart and hepatic profile.

Keywords: Nanoparticles, nanotoxicology, drug delivery, hypercholesterolemia

NEURAL NETWORK BASED MODELING OF DRUG PERMEABILITY THROUGH THE BLOOD–BRAIN BARRIER

Idit Golani and **Mati Golani** (Department of Software Engineering)

The pharmaceutical industry is increasingly interested in grappling with the challenge of predicting properties such as absorption, distribution, metabolism and excretion (ADME) of central nervous system medications. Blood–brain barrier (BBB) permeability is an important ADME property and plays a major role in drug design. The experimental determination of BBB permeation is often complex and time-consuming. For modeling purposes, however, data sets of BBB permeation can be derived from databases of known drugs. In this research, a neural network is developed to learn the "sense" of the pharmacokinetic properties of known drugs and to use this data to predict the permeation of newly designed drugs.

Keywords: Schizophrenia, blood–brain barrier, central nervous system, antipsychotics, drug delivery, neural network

NEUROPHARMACOLOGY

Idit Golani, **Rosa Azhari** (Azrieli College of Engineering Jerusalem), and **Alon Shamir** (Mazor Mental Health Center)

The blood-brain barrier (BBB) restricts the transport and efficacy of drugs in the brain in pathological situations such as neurodegenerative diseases and psychiatric disorders. Recently it has been shown that nanoparticles (NPs) can cross the BBB using carrier-mediated transport without causing any damage to the BBB. The main research objective is to develop a platform for targeting active materials to the BBB and enhancing their passage through the BBB, using carrier-mediated transport of NPs. Nanoparticles, comprised of an antipsychotic drug and a carrier protein, were produced by a solvent evaporation technique. The stability, selectivity, and efficiency are examined by *in-vitro* and *in-vivo* studies.

Keywords: Schizophrenia, blood–brain barrier, central nervous system, antipsychotics, drug delivery, nanoparticles

Idit Golani and Alon Shamir (Mazra Mental Health Center)

Genetic and functional evidence of the involvement of NRG1 and ErbB4 receptors in the etiology of schizophrenia is accumulating. The main research objective is to explore the effect of pharmacological inhibition of the ErbB4 signaling pathway on behaviors relevant to the core symptoms of schizophrenia in adolescent and young adult mice.

Keywords: Schizophrenia, blood–brain barrier, central nervous system, antipsychotics, drug delivery, neural network

Isam Sabbah

Accumulation and spreading of microplastics and associated wastewater pollutants

The main objective of this research is to develop a thorough understanding of microplastic (MP) occurrence and microplastic-facilitated transport of organic pollutants in wastewater.

GoJelly- A gelatinous solution to plastic pollution

Characterization & quantification of MP in wastewater effluent:

- Cleaned-up samples of organic material (chemical and enzymatic digestion)
- Identification and quantification of MP (FTIR-ATR, mFTIR, SEM, microRAMAN)
- Biofilter for microplastic removal from wastewater (development)

Keywords: Microlastic, nanoplastic, wastewater treatment systems, jellyfish, mucus, marine ecology

Exposure Risks of Pathogens and Disinfection Byproducts from On-Site Treated Rainwater and Drainage Water for Irrigation

This comprehensive study will determine the relative potential human health impacts of irrigation water used in urban and small farms in both dry climates (Israel and American South and Southwest) and temperate climates of the American North and Midwest. Students will be involved in the development of organic fractionation of disinfection by-products using different chromatography methods.

Keywords: Drainage water, disinfection byproducts (DBP), Ozonation, chlorination, cytotoxicity

ENDOPHYTIC BACTERIA IN AGRICULTURE

Lilach Iasur Kruh

In recent years, there has been growing public pressure toward the use of "green products" in agriculture because of the negative impact of chemical spraying on the environment and the emergence of pesticide resistance. One environment-friendly solution is microbial biocontrol agents.

The internal tissues of most plants are naturally inhabited by endophytic bacteria that do not harm their hosts. These bacteria often play a major role in numerous aspects of their host plant's biology. Cases showing a mutual host–bacterium benefit include enhanced host growth rate, acceleration of seed germination, tolerance to stress, and supply of critical nutrients to the host. Endophytic bacteria can also contribute to plant disease resistance by suppressing pathogens and enhancing the plant's immune system.

This research focuses on identification and isolation of endophytic bacteria that can be used as a biocontrol agent against plant diseases and/or as biostimulators for improving plant growth. Using both classical and molecular microbiology methods, the application of these bacteria will be calibrated, and a suitable formulation will be manufactured to make it simple for farmers to use.

Keywords: Endophytic bacteria, bio-control, agriculture

SMALL MOLECULE INHIBITORS OF PROTEIN BINDING TO HEPARAN SULFATE – INHIBITORS OF INFLAMMATION WITH DRUG DELIVERY POTENTIAL

Nicolas Harris

Heparan Sulfate (HS) is a linear polysaccharide found in all animal tissues. HS is found bound to cell surface proteins and extra cellular matrix proteins. Protein ligands of HS regulate a variety of biological processes including angiogenesis, blood coagulation, and tumor metastasis and are cellular receptors for viruses. Rimonyx Pharmaceuticals (Israel), in collaboration with the Department of Biotechnology Engineering at ORT Braude College, has identified small molecule amphipathic amines that inhibit the in vitro binding of inflammatory proteins to heparin, an analog of HS. The same compounds, active in mouse peritonitis, paw edema and delayed-type hypersensitivity, display anti-viral activity and are potential therapeutic inhibitors of inflammation. Their mechanism of drug action was demonstrated by direct binding of the small molecules to heparin. This mechanism of action may account for the therapeutic activity of small molecule cationic acridines, phenothiazines, and their congeners—chloroquine, quinine and tilorone—that are used to treat malaria, viral diseases, cancer, rheumatoid arthritis and neurodegenerative diseases.

Conventional enteral and parenteral drug treatments are characterized by poor bio-distribution, lack of selectivity and limited effectivity. These shortcomings are being addressed by the development of drug delivery systems that directly transport drugs to their targets. Anti-inflammatory small molecules, that bind directly and with specificity to HS, are being developed as drug delivery vehicles. A prototype of the drug delivery system was constructed from anti-inflammatory small molecules and a reporter plasmid encoding green fluorescence protein (GFP). Transfection of cells in tissue culture showed that the construct facilitated reporter plasmid transfection.

Keywords: heparin sulfate, inflammatory diseases, small molecule drugs, drug delivery

ANTIOXIDANT PROPERTIES OF STEVIA REBAUDIANA PLANT

Rivka Weiser Biton

The worldwide use of Stevia rebaudiane as a substitute sweetener for sugar is increasing every year. Stevia rebaudiane is not involved in the insulin mechanism and so has no calories. This makes Stevia rebaudiane a natural substitute for the more common synthetic substitutes for sugar.

Various studies show that the Stevia rebaudiane plant contains substances with antioxidant reagent properties, and as such can prevent antioxidation damage to DNA.

The aim of the project was to find optimal conditions for the process so that the antioxidants in the Stevia plant are preserved. Methods used for testing were redox-titrations and spectrophothometric methods.

In all results, Vitamin C was used as reference for the antioxidation activity. The results show that the Stevia rebaudiane plant is active as an antioxidant reagent, and that the extent of the antioxidant activity depends on the solvent and on the conditions of the extraction process.

Keywords: Stevia rebaudiane, natural substitute for sugar, extraction process, antioxidating activity, methods for testing

DRUG DELIVERY TO THE BRAIN

Rosa Azhari, **Idit Golani**, and **Alon Shamir** (Mazra Mental Health Center)

The high selectivity of the blood–brain barrier (BBB) prevents up to 98% of all central nervous system (CNS) discovery compounds from reaching their targets in the brain, leading to greater concentration of drugs in peripheral tissues as well as side effects. Antipsychotic medications reduce the psychotic symptoms of schizophrenia and other mental illnesses. Newer antipsychotic drugs such as Clozapine (Clozaril), and Olanzapine (Zyprexa) also lead to metabolic side effects such as weight gain, increased glucose and lipids, and even severe side effects such as agranulocytosis. Novel drug delivery systems should enhance drug penetration to the CNS, reduce side effects, and improve patient compliance. This research examines an approach for targeting these drugs to the CNS.

Keywords: Schizophrenia, blood–brain barrier, central nervous system, antipsychotics, drug delivery, neural network

PREECLAMPSIA: EXOSOMES AND GALECTINS

Marei Sammar

Preeclampsia affects 2-7% of pregnancies and is a major cause of maternal and fetal mortality and morbidity. This hypertensive disorder develops from mid-gestation and may exacerbate into eclampsia, characterized by brain convulsions and stroke. The only effective cure is to deliver the baby. Although placentation failure is anticipated, the etiology is still unknown, and preeclampsia remains the "disease of theories".

Early studies revealed that the serum galectin-13 serves as a prediction biomarker for preeclampsia, based on its low level in the first trimester of pregnancy. Although soluble galectin-13 can be detected in maternal and fetal blood and in the amniotic fluid, the biological relationship between preeclampsia and galectin-13 is not understood. Our hypothesis is that galectin-13 is part of the placental-derived extracellular vesicles (EVs) and may deliver the "danger signals" or "rescue signals" at the placentation phase of early pregnancy. Recently we used the *ex-vivo* dual placental lobe perfusion model to enrich and isolate syncytotrophoblast extracellular vesicles (STBEVs) from normal term and preeclamptic placentas using sequential centrifugation and filtration. Our findings support the notion that galectin-13 is part of the proteomic cargo of two populations of placental STBEVs: STB enriched microvesicles and STB enrich exosomes.

The galectin-13 levels in STB microvesicles and exosome were significantly lower in preeclampsia compared to normal controls. Vesicular galectin-13 is localized both inside the STBEVs and at the surface of STBEVS.

The current research focuses on:

1. Quantification of galectin-13 levels in placental-derived extracellular vesicles-EVs (microvesicles and exosomes) in the maternal blood during the pregnancy.
2. Quantification of soluble galectin13 vs galectin13 ^{positive} EVs ratio in the maternal blood of preeclamptic women compared to normal pregnancy and evaluation of its potential to serve as diagnostic/prognostic biomarker.

3. Development of novel microfluidic device combined with nanophotonic structures to detect placental EVs.
4. Evaluate the role of PP13 ^{positive} EVs in signaling of the immune and endothelial systems that are affected in preeclampsia.

Keywords: Preeclampsia, galectin-13, exosomes, placenta, biomarkers

TISSUE ENGINEERING OF INTERVERTEBRAL DISC

Sarit Sivan and **Michal Amit**

Disc degeneration and accompanying low back pain (LBP) impose a major medical and societal cost. The normal functioning of an intervertebral disc (IVD) is governed by its major macromolecular constituents— collagen and the large aggregating proteoglycan (PG)— aggrecan, distributed across the central gelatinous nucleus pulposus (NP) and the outer annulus fibrosus. Aggrecan, apart from its role in imbibing water and distributing loads, also inhibits ingrowth of both nerve and endothelial cells. With the onset of disc degeneration, PG is lost from the disc's inner regions, resulting in water loss and concomitant loss of disc height. Increased innervation and vascularization, which are related to the development of 'discogenic' LBP, have also been reported. An IVD can potentially trigger self-healing due to the presence of progenitor cells, specifically notochordal cells, which participate in disc development. With the onset of disc degeneration, NP cells produce less extracellular matrix (ECM), which limits disc regeneration potential. The activity of NP cells, however, can be regained by co-culturing them with mesenchymal stem cells (MSCs).

The main goals of our study are to test the capability of a novel series of biomimetic GAG analogues, developed by Sivan et al., to function as BM-MSC carriers and to promote the production of NP-like ECM via cues delivered to the cells by their unique structural characteristics. Accordingly, BM-MSCs will be cultured in GAG analogue hydrogels of different stiffnesses. Constructs will be incubated under IVD-like conditions of osmolarity in the presence and absence of differentiation factors. They will be tested for tissue organization and assessed for cell viability, biochemical composition, and the presence of NP-phenotype markers using gene expression. The ability of GAG analogues to delay nerve growth will also be assessed.

Keywords: intervertebral disc, proteoglycan, disc degeneration, tissue engineering

USING DESALINATION BRINE IN AQUACULTURE

Sivan Klas

Brine originating from brackish water desalination is currently disposed of in the environment without any use being made of it. The study aims to understand if and how this water source may be used in aquaculture, as it is free of costs and pathogens. The main concern is $CaCO_3$ precipitation on fish organs that caused mortality in past tests. The research is focused on

developing a cost-effective softening process and on studying its effect on fish grown with different culture technologies.

Keywords: Desalination, aquaculture, softening

CONVERTING GASEOUS AMMONIA EMITTED FROM LIVESTOCK HOUSING INTO A FERTILIZER

Sivan Klas

Ammonia produced in livestock housing is toxic to the animals and is also an environmental problem. On the other hand, nitrogen fertilizer production is energy intensive, leading to a relatively high product price. The research is aimed at developing a cost-effective technology for transforming gaseous ammonia into a liquid or solid fertilizer.

Keywords: Ammonia, emission, fertilizer

TRANSLATIONAL ASPECTS OF NEURODEGENERATIVE DISEASE, INFECTIOUS DISEASES, AND CANCER

Marcela Viviana Karpuj

Advanced technologies and scientific discoveries have significantly increased our lifespan. However, diseases associated with aging, such as neurodegenerative disorders (NDS) and cancer, have become a major health problem with severe social and economic burdens on individuals and governments. This research focuses on translational aspects of NDS and cancer by combining next generation sequencing (NGS), biochemistry, molecular biology, proteomics, in silico tools, and in vitro and in vivo models of NDS and cancer. The emphasis is on Huntington's, Prion diseases, Alzheimer disease, and cancer associated with membrane proteins. The aim is to explore the various aspects of these diseases to accelerate the development of novel technologies and potent drugs that will cure patients within our lifetime.

Keywords: Neurodegenerative disorders, infectious diseases, cancer, membrane proteins, personalized medicine, next generation sequencing, nanotechnology, blood brain barrier, V3EGFR

IDENTIFICATION OF EFFECTOR PROTEINS SECRETED BY BACTERIAL SECRETION SYSTEMS

Dr. Eran Bosis

In the study of host-pathogen interactions and competition between bacteria, the main focus is the identification of new effectors secreted by bacterial secretion systems (mainly type III and VI secretion systems). The research employs a computational biology approach with an emphasis on advanced data mining and machine learning to analyze large of amount of biological data.

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JOURNAL REFEREES

M. Grozovski

2012 - 2016	Journal of Hepatology, September, 2012
2011 - 2016	Journal of Clinical and Experimental Pharmacology and Physiology, April, 2011

S. Sivan

2015 - present	Osteoarthritis and Cartilage
2013 - present	Advanced Drug Delivery Reviews
2013 - present	Israel Journal of Chemistry
2012 - present	Connective Tissue Research
2012 - present	Spine
2011 - present	Cartilage
2010 - present	Acta Biomaterialia
2007 - present	European Spine Journal

M. Sammar

2012 - present	Reproductive Sciences
2014 - present	Placenta
2015 - present	Pathology and Pathohistology
2016 - present	Experimental and Molecular Pathology
2017 - present	ScienceMatters

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I. Sabbah, Anaerobic treatment of wastewater in the context of circular economy, *the 15th conference on Small Water & Wastewater Systems and the 7th Specialized Conference on "resources Oriented sanitation", IWA*, Haifa, Israel, October 14-17, 2018 (Invited Keynote Speaker).

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S. Sivan

10th World Biomaterial Congress (WBC2016)

Department of Electrical & Electronic Engineering

Dr. Nissim Sabag
Head of Department

RESEARCH AREAS

CONTROL ENGINEERING

Eduard Eitelberg

Considerate control: feed-forward and feedback. Turbo-generator frequency and voltage control. Monetary and fiscal feedback control in national economies.

Keywords: Control, MIMO control, interaction, monetary policy, fiscal policy

NANOELECTRONIC COMPUTER ARCHITECTURE

Michael Gladshtein

Design of non-traditional approaches to nanocomputer implementation on quantum-dot cellular automata.

Keywords: Nanocomputer, quantum-dot cellular automata, serial decimal processing, Johnson-Mobius code

SIGNAL AND IMAGE PROCESSING, COMPUTER VISION, AUDIO AND BIOLOGICAL SIGNAL PROCESSING

Evgeny Gershikov

Algorithms that recognize information about the speaker or the music that are present in an audio signal. For example, the speaker or his/her emotional state can be recognized.

Object detection and recognition in images and video sequences as well as tracking targets in video. An example of such a task is road sign or lane border recognition for self-driving cars.

Biological signal processing, namely, ECG and EEG.

Keywords: Signal processing, image processing, computer vision, speech and speaker recognition, biological signal processing, pattern recognition, machine learning

IMAGE PROCESSING; PEDAGOGIC TOOLS

Samuel Kosolapov

Image processing: algorithms for fast extraction of features.

Pedagogic tools: logistics and software to provide short micro exams during the lecture.

Keywords: Image processing, Monte-Carlo, embedded systems, pedagogical tools

PHOTONIC DEVICES

Vladislav Shteeman

Development of new analytical and numerical approaches for coupled-mode analysis of advanced photonic devices such as phased laser arrays, arrays of coupled waveguides, photonic crystal fibers, and waveguides.

The research is conducted in collaboration with Prof. Amos A. Hardy from the Department of Electrical Engineering – Physical Electronics, of Tel Aviv University.

Keywords: Photonic devices, arrays of coupled waveguides, phased laser arrays, coupled-mode theory

ELECTRICAL AND ELECTRONICS ENGINEERING EDUCATION

Nissim Sabag

Investigation of different aspects of engineering education such as problem-based learning and students' motivation, online education, mathematical vs. engineering understanding, and learning styles.

The research is conducted in collaboration with the Technion–Israel Institute of Technology and other colleagues.

Keywords: Animation based learning, active learning, promotion of teaching

ELECTRICAL AND ELECTRONICS ENGINEERING EDUCATION – STUDENTS' MATHEMATICAL UNDERSTANDING VERSUS ENGINEERING UNDERSTANDING

Elena Trotskovsky

Exploration of how B.Sc. engineering students at an academic college of engineering perceive engineering and mathematical understanding and the interrelationships between them.

Keywords: Conceptual understanding, procedural understanding, applicable understanding

PERCEIVED IMAGE QUALITY ASSESSMENT

Pinchas Zorea

Perceived image quality assessment: assessment of perceived image quality for smartphones with embedded cameras.

Keywords: Objective image quality assessment, subjective image quality assessment, human visual tests (HVT), mean opinion score (MOS), image quality attributes

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E. Smith, L. Giladi, V. Shteeman, and **A. Hardy,** Analytical approximation for photonic array modes in 2D photonic devices. *Proceedings of 2016 IEEE International Conference on the Science of Electrical Engineering (ISCEE)*, Eilat, Israel, 16-18 November, 2016.

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N. Sabag, M. Shacham, and **A. Gero,** Why do successful engineering students succeed? – Work in progress. *13th ORT Braude College Interdisciplinary Research Conference*, Nahsholim, Israel, 2017.

N. Sabag and **H. Kirsher,** About the correlation between the distance of trainees' learning styles to their tutors' instructional strategies and the trainees' academic achievements. *12th ORT Braude College Interdisciplinary Research Conference*, Hgosrim, Israel, 2016.

S. Kosolapov, Extended model of the pinhole camera. *12th ORT Braude College Interdisciplinary Research Conference*, Hgosrim, Israel, 2016.

Department of Industrial Engineering & Management

Dr. Boris Shnits, Ph.D.
Head of Department

RESEARCH AREAS

QFD METHODOLOGY FOR LINKING PROJECT SUCCESS FACTORS TO OUTCOMES IN A SPECIFIC BUSINESS CASE

Shuki Dror and **Oren Eliezer**

Defining Project Success (PS) outcomes and PS factors is not an easy task. A favorable outcome depends on the stakeholders' perspective, the project type, the project life cycle stage, and organizational characteristics. The present study focuses on an individual business case to develop a procedure for quantitative evaluation of the relations between various PS factors and outcomes based on the Quality Function Deployment (QFD) method.

A House of Project Success (HoPS) matrix is created using combined input from various managers and experts. This matrix summarizes the desired improvements in the PS outcomes and connects them to the relevant PS factors. Based on the HoPS matrix, outcomes and factors that maximize the desired results of the PS policy are chosen using the Mean Square Error (MSE) criterion.

The paper describes the implementation of the above methodology in two organizations and two project types, namely weapons development and an ERP implementation, demonstrating different project success causal structures.

Keywords: Project success factors, project performance, Quality Function Deployment (QFD), Mean Square Error (MSE), decision-making

LINKING OPERATIONAL PLANS TO BUSINESS OBJECTIVES USING QFD

Shuki Dror

Selection of appropriate operational plans is an essential yet complex task as it requires an understanding of the implications for the strategic objectives in a given industrial situation. This research utilized the Quality Function Deployment (QFD) method as an instrument for ranking the operational plans of an individual organization in terms of its business objectives.

Two methodological stages are suggested. In the first stage, a "House of Strategy" matrix translates the improvement needs of a company's objectives into a list of competitive priority measures ranked according to their relative importance. A Mean Square Error (MSE) criterion supporting the selection of vital competitive priorities to be improved is employed. In the second stage, each vital competitive priority is broken down into its relevant process scenarios, and an operational matrix is constructed to translate the desired improvement in the process scenarios into a list of operational plans ranked by importance. Again, the MSE criterion supports the selection of vital operational plans. In the construction of the operational matrix, it is assumed that synergy between the operational plans might change for each process scenario; i.e. there might be several roofs, corresponding to the number of rows in the operational matrix.

Keywords: Strategy implementation, business objectives, operational plans, Quality Function Deployment (QFD)

IDENTIFY IMPORTANT FACTORS FOR SERVICE SIMULATION EXPERIMENTS USING QFD

Shuki Dror

Service design is a form of conceptual design that involves the activity of planning and organizing people, infrastructure, communication, and material components of a service to improve its performance. A simulation experiment models the various scenarios of a service system. One of the aims of the designer is selecting appropriate factors for the determination of the simulation scenarios. The complete set of possible scenarios is huge, so it is often useful to get subjective input to help screen some vital factors. Taguchi advocates a three-stage design procedure for off-line quality control: (i) system design; (ii) parameter design; and (iii) tolerance design. In the parameter design stage, which is the key stage in the Taguchi method, factors affecting the performance of Y are categorized as controllable factors and noise factors. In this paper, a Quality Function Deployment (QFD) matrix highlights controllable factors and noise factors to consider when running a simulation experiment for a service system. It is assumed that interactions between the factors might change for each performance measure; i.e. there might be several roofs, corresponding to the number of rows in the QFD matrix. The MSE criterion is utilized here for selecting the vital service factors to be examined in the simulation experiments.

Keywords: Service design, simulation experiments, Quality Function Deployment (QFD)

MATRIX APPROACH TO ANALYSIS OF HUMAN ERROR AND THEIR PREVENTION BY QUALITY ENGINEERING AND MANAGERIAL TOOLS

Emil Bashkansky and **Shuki Dror**

This research applies well-known quality engineering matrix techniques such as quality function deployment, Teoriya Resheniya Izobretatelskikh Zadatch (TRIZ), and failure mode, effects, and criticality analysis for characterizing, mapping, and preventing human error (or, at least, reducing damage caused by errors). Human errors ('WHATs', in the language of quality function deployment) are classified according to ten characteristics, while twenty typical types (or protective layers)—'HOWs'—in quality assurance systems are proposed for preventing/stopping/minimizing, to some extent, damage caused by errors. During the analysis of a specific system, any error is estimated according to its likelihood and severity, and every protective layer receives a score according to its effectiveness in preventing errors. Synergy or antagonism between protective layers may also be taken into account when calculating effectiveness. The approach facilitates evaluation and comparison of the effectiveness of different quality assurance systems dealing with human errors. The authors emphasize the need to create a 'recipe book' based on historical databases, which will enable application of the optimal prevention efforts after characterizing the potential human errors according to the ten criteria mentioned above.

Keywords: Human errors, prevention, quality engineering tools, QFD, TRIZ, FMECA

TAGUCHI METHODS FOR OFF-LINE QUALITY CONTROL

Irad Ben-Gal and **Shuki Dror**

Three decades ago, Taguchi developed a systematic approach to off-line quality control and process design that is now known as the Taguchi method. Although some statistical aspects of the method are debatable, there is no argument that it has been widely applied to various processes and industries and has gained enormous attention. This study summarizes the main concepts of the Taguchi method and covers some of its implementations.

Keywords: Robust design, quality control, process optimization, parameter design, design of experiments, statistical experiments

A CORPORATE SOCIAL RESPONSIBILITY (CSR) MODEL – A QUALITY FUNCTION DEPLOYMENT-BASED METHODOLOGY

Natalia Zaitsev and **Shuki Dror**

Corporate Social Responsibility (CSR) aims to increase long-term profits through positive public relations, to establish high ethical standards to reduce business and legal risks, and to boost shareholder trust by taking responsibility for corporate actions. CSR strategies encourage the company to make a positive impact on the environment and stakeholders, including consumers, employees, investors, and communities.

The goal of an organization is a sustainable context called CSR outcomes. According to discussions in the literature, the main outcomes of CSR are reputation, consumer loyalty and positive firm evaluation, stakeholder relations, customer choice of company/product, financial performance, firm capability, reduced risk, and enhanced organizational identification.
The study seeks to create a framework that investigates the relationship between all types of indicators of an organization's activities and the CSR outcomes at the institutional level of CSR analysis. A structured methodological approach based on a Quality Function Deployment (QFD) is developed.

Keywords: Corporate Social Responsibility (CSR), Quality Function Deployment (QFD), CSR outcomes

A NEW FRAMEWORK FOR ORGANIZATIONAL KNOWLEDGE THAT ENABLES CRITICAL JUSTIFICATION

Doron Faran

Knowledge is defined as "justified true belief", but knowledge management pays very little attention to either justification or truth. This paper reviews the justification methods that organizations employ de facto — positivism, conventionalism and pragmatism and discusses their weaknesses. The method of critical rationalism (CR) is then presented as a remedy for these weaknesses, and the opposition to this method in the organizational field is discussed. A new knowledge framework that realigns the canonical theories of organizational knowledge is constructed. The main argument in this paper is that the framework does facilitate CR. The implementation of CR is demonstrated in a case study.

Keywords: Knowledge, truth, justification, critical rationalism

ADVERTISING EFFECTIVENESS FROM THE HERMENEUTIC STANDPOINT

Doron Faran and **Arie Maharshak**

The core of the research focuses on the dilemma of advertising effectiveness. On the one hand, companies tend to invest substantial amounts of money in promoting their products, while on the other hand, customers quite often fail to understand the message embedded in a marketing campaign. Consequently, highly valued campaigns that receive prestigious awards do not deliver. While the failures of advertising campaigns have been thoroughly investigated in the literature, few explanations for the failures have been proposed. This contribution builds on the criticism of cognitive narrowness and takes the cultural stance a step further through application of the hermeneutic tradition.

Keywords: Advertisement, hermeneutics, interpretation, culture

APPLIED PROBABILITY

Tamar Gadrich, **Haggai Katriel**, and **Rachel Ravid**

Applied probability is concerned with the application of probability theory to other scientific and engineering areas (e.g. physics, biology, medicine, computer science, technology, and social sciences). This research applies generalizations of classical models to solve problems that have emerged in modern industry. Occupancy models are an example of one of the models used to generalize the classical coupon collector problem and applied in the area of statistical quality control.

Discrete-time population models are widely used in the field of population ecology. The population-level consequences of assumptions regarding the behavior of individual organisms is investigated using site-based models (a bottom-up approach). We applied stochastic processes (discrete time Markov chain and Gaussian Markov chain approximation) and agent-based simulation approaches to investigate system dynamics.

Keywords: Probability models, statistical quality control, occupancy problems, enumerative combinatorics, mathematical biology, ecology, population dynamics, site-based models

CROSS CULTURAL HUMAN RESOURCE (HR) MANAGEMENT

Hilla Peretz and **Yitzhak Fried** (Texas Tech University, USA)

Cross-cultural management focuses on content pertaining to HR management with a cross-border dimension. This longitudinal research study examines the effects of national values on a variety of HR practices (among them, performance appraisal, training strategies, and HR information systems) as well as the effect of fit between HR practices and national values on organizational performance indicators. The study comprises a large sample of over twenty countries and is based on data from several years, with the goal of exploring the stability of these relationships before and after the financial crisis.

Keywords: National values, human resource management, organizational performance

ENVIRONMENTAL ECONOMICS

Natalia Zaitsev and **Mira Baron** (Technion—Israel Institute of Technology)

In the mid-1990s, we forecast the number of Israeli visitors to a unique planned recreational site in the north of Israel, currently known as Agmon Hula. The contingent valuation method used to predict this number was based on tourists' willingness to visit the planned site from among all the recreational sites in the region.

The current study examines the assumptions and results of that study and compares the forecast to the actual outcome. We concentrate on the number of visitors forecast, which enables us to examine the economic impact and is crucial in analyzing the ecological carrying capacity.

The planned commodity was a site offering a safari, a bird sanctuary, horseback riding, a

swimming pool, and a picnic area. The project, however, was not carried out as planned, and currently is a bird sanctuary only.
The forecast of 380,000 visitors in the first year of operation did not materialize. The prediction might have been closer to the actual number (220,000) if we had considered the percentage of respondents who ranked visiting bird sanctuaries as one of their two favorite activities.
Updating the predicted number of visitors is straightforward and plays a crucial role in predicting carrying capacity. A new forecast of the number of visitors over the next twenty years is made.

Keywords: Recreational site, forecasting the number of visitors, contingent valuation method

FLEXIBLE MANUFACTURING SYSTEMS (FMS): OPERATIONS AND CONTROL

Boris Shnits

Flexibility in FMS is made possible largely owing to the use of versatile and/or redundant machines, which in turn facilitate alternative system routing. Alternative routing enhances a system's ability to better balance machine workloads and achieve higher system robustness and productivity. To fully exploit these features, an FMS must be able to adapt to different shop conditions, i.e. for a given system status to select the appropriate operational policy in real time. This research focuses on developing methodologies and control schemes that enable an FMS to improve its efficiency and productivity and to cope with the volatile production environment in which the FMS operates. These control schemes deal with solving a multi-criterion, dynamic scheduling problem using optimization-based techniques and simulation.

Keywords: FMS control, dynamic scheduling, multi-criteria decision making, simulation

FLEXIBLE WORK ARRANGEMENTS: A CROSS-CULTURALPRESPECTIVE

Hilla Peretz and **Yitzhak Fried** (Texas Tech University, USA)

Flexible work arrangements (FWAs) have become increasingly prevalent in the global competitive environment. Little is known, however, about how societal cultures affect the implementation of FWAs and their effect on organizational outcomes. This research addresses this issue by focusing on two complementary topics: (a) the influence of five important societal (national) cultural values (power distance, uncertainty avoidance, individualism/collectivism, assertiveness, and future orientation) and key organizational variables; and (b) the contribution of the level of congruence between these societal cultural values and FWAs on the organizational outcomes of absenteeism and turnover.

Keywords: Flexible work arrangements, national culture, organizational outcomes

GENERATION Y: A CROSS-CULTURAL PERSPECTIVE

Hilla Peretz and **Emma Parry** (Cranfield University, UK)

Increased life expectancies and initiatives to retain older workers for longer means that the workforce is becoming more age-diverse. Hence, to effectively attract and manage this new cohort of employees, employers need to develop a clear understanding of the work values, preferences, and attitudes of the new generation entering the workforce (generation Y) and how they might differ from previous generations. To date, research and practical advice has largely ignored the impact of national or cultural context on this diversity. This lacuna may explain the failure of so many studies to find generational differences in work values if the samples used were not from a single nationality. Specifically, the main question of this study is to examine whether generational differences (in work values and work behaviors) are different among different cultures or are global. To empirically examine the study question, a novel strategy is used: data mining of social networks and turnover.

Keywords: Generations, work values, national culture

HUMAN FACTORS IN DESIGNING JOINT COGNITIVE SYSTEMS FOR MANUFACTURING

Nirit Gavish and **Hussein Naseraldin**

Recently, several cognitive systems for manufacturing management have been developed. In these systems, human and artificial intelligent entities work together as a team in a situation termed a "Joint Cognitive System." Humans utilize the computerized system most effectively if they accept the system's analysis of the problem and recommendations for handling it. The assumption is that in joint cognitive systems for manufacturing, human performers begin their interaction and decision-making processes using an explicit, analytic, theory-based style. After gaining experience with the results of their decisions, they shift to an implicit, experience-based, non-analytic style. Hence, to achieve good cognitive coupling, the computerized system should adapt itself to performers' shifts in cognitive style. In other words, the system input should be analytic and theory-based at the beginning (e.g. "According to model X, the recommended production plan is Y"), and later be heuristic and experience-based (e.g. "Last time, in a similar situation, you chose production plan Y"). The research hypothesis regarding the contribution of an adaptive cognitive style to the performance of the joint cognitive system is empirically evaluated in a manufacturing management setting using simulation. The research is conducted in two phases. The first phase examines the hypothesis regarding the changes in the operator's cognitive style. The second phase evaluates the effect of the system's cognitive style using different cognitive styles in various stages and levels of interaction. Participants are freshmen students in the Department of Industrial Engineering and Management at ORT Braude Academic College of Engineering, Israel, who are enrolled in the Introduction to Industrial Engineering course.

Keywords: Joint cognitive systems, manufacturing, decision making, cognitive style

HUMAN RESOURCE AUTONOMY WITHIN MULTINATIONAL CAOMPANIES

Hilla Peretz and **Mila Lazarova** (Simon Fraser University, Vancouver, Canada)

Growing organizational dependence on international operations highlights the role of human resource management and confronts organizations with the dilemma of having to find the right balance between global integration and local responsiveness. This research examines whether and under what circumstances subsidiary human resource autonomy enhances performance indicators. It seeks to answer two major research questions: (1) Whether a higher level of subsidiary human resource autonomy is associated with improved subsidiary performance; and (2) Whether the relationship between level of subsidiary human resource autonomy and subsidiary performance is influenced by cultural and institutional distance between the multinational company's headquarters and the subsidiary.

Keywords: Multinational companies, human resource, performance

HUMAN RESOURCE MANAGEMENT – DIVERSITY STUDY

Hilla Peretz

The realization of the importance of group diversity is growing rapidly among organizations and research theorists. Diversity has been credited with both positive and negative outcomes for team performance. The research explores two major topics: (1) The factors influencing positive implementation of diversity with regard to group performance and its effectiveness; and (2) The acceptance of affirmative action in different contextual settings (both organizational and national) and its influence on performance.

Keywords: Diversity, team performance

INVENTORY MANAGEMENT

Illana Bendavid, **Hussein Naseraldin**, and **Yale T. Herer** (Technion—Israel Institute of Technology)

A major decision in the supply chain context is the inventory level of a product along the supply chain. The inventory level affects the service level the customer receives and thus affects operational performance. Even though decisions regarding inventory levels are typically made after several other strategic and tactical decisions, integrating inventory decisions with strategic decisions at an early stage has a crucial effect on overall performance. Inventory management encompasses inventory policies and practices. For example, lateral transshipment is a practice in which excess inventory is moved along the supply chain to locations with a shortage of inventory, thus eliminating excess and shortage costs.

Keywords: Inventory policy, inventory-location model, lateral transshipments, unit-price discount

LINE BALANCING

Boris Shnits

Production or assembly line balancing refers to assigning work elements and resources to workstations on the line so that the workload at all workstations is equal. One specific research direction involves the balancing of a robotic assembly line. In robotic assembly line balancing (RALB), the problem is that different robots may be assigned to assembly tasks; and each robot, because of its capabilities and specialization, needs different assembly times to perform a given task. The solution to the RALB problem includes finding the optimal assignment of robots to line stations and achieving a balanced distribution of work among the different stations. A genetic algorithm is used to find a solution to this problem.

Keywords: Line balancing, robotic assembly lines, genetic algorithms

MULTINATIONAL CORPORATIONS' (MNCs) PERFORMANCE IN THE POST-GLOBALIZATION ERA

Hilla Peretz and **Michael Morely** (Limerick University, Ireland)

Multinational Companies (MNCs)— defined as large corporations incorporated in one country and producing or selling goods or services in various countries — stand at the center of globalization and serve as the engine of international business. The shift to a deglobalization phase —specifically, the reality that the world is becoming more uncertain and unpredictable due to the emergence of international conflicts, protectionism, and nationalism — represents a challenge to MNCs, their strategies, and their performance. Although the effects of deglobalization on societies are starting to be studied in the economics and sociology literature (for example, Hillebrand, 2010, who studies the effects of deglobalization on income equality; or Casery, 2017, who examines the phenomenon from an historical point of view), the mainstream literature of international management and organizational studies has yet to explore how this new phenomenon affects organizations in general and MNCs in particular. This study explores how and under which circumstances deglobalization affects performance of MNCs.

Keywords: Multinational corporation, organizational performance, deglobalization

ORGANIZATIONAL AFFIRMATIVE ACTION PROGRAMS

Hilla Peretz, **Ariel Levi** (Wayne State University, USA), and **Yitzhak Fried** (Texas Tech University, USA)

Organizational affirmative action programs (AAPs) have been widely adopted in the US, and have been extensively investigated as a major human resource activity. Over the past four decades, organizations have implemented AAPs to remedy discrimination against ethnic and racial minorities, women, and disabled people, and to diversify their workforces. Interestingly, AAPs have been implemented not only in the US, but also in organizations in other countries and

cultures. Despite the increased globalization in the business environment, however, there is a paucity of research on the prevalence of AAPs across nations, and on whether societal values affect the type of AAPs that organizations implement.

Keywords: Affirmative action programs, national culture, absenteeism, turnover

PROJECT MANAGEMENT AND SCHEDULING

Illana Bendavid and **Boaz Golany** (Technion—Israel Institute of Technology)

Project scheduling is one of the nine knowledge areas in the body of knowledge comprising project management. This area is the keystone of project planning and control since it requires and integrates information about several project characteristics such as estimated duration of activities, precedence constraints deriving from the technological precedence relations among the activities, resource constraints, and due-date constraints. After this information has been processed, the scheduling activity generates a feasible schedule that optimizes one of the multiple existing objective functions such as minimization of project duration, maximization of a project's net present value (NPV), and many others. This feasible schedule is generally used as a baseline schedule according to which commitments with external entities are made for planning activities such as material procurement and delivery of orders. In other words, this schedule determines when suppliers have to deliver materials needed for the project's activities, and also sets due dates for subcontractors who execute some project tasks.

Keywords: Stochastic project scheduling problem, activity gate, flexible commitment, resource management, project control

QUALITY, DEPENDABILITY, HEALTHCARE, AND SAFETY ENGINEERING

Emil Bashkansky, **Tamar Gadrich**, **Shuki Dror**, **Rachel Ravid**, and **Yariv Marmor**, in cooperation with the Department of Applied Mathematics

This research focuses on effective methods for evaluation, analysis, statistical control, prediction, and improvement of quality measured using categorical scales. Such scales are widely used in other fields of quality and safety engineering: customer satisfaction surveys, FMECA and risk analysis, defects and quality classification, inter- and intra-laboratory comparisons, homogeneity/heterogeneity tests, statistical process control, human error classification and prevention, testing, diagnostics, healthcare analysis, QFD, and others. In turn, design and analysis of optimal control schemes for such scales facilitates effective quality data mining and determination of dominant distinguishing parameters. Some of the developed methods are ready for immediate industrial application and are applied in decision making for patient-involved health care, product quality classification and control, security arrangements, and metrology.

Keywords: Quality control, categorical data analysis, prediction, improvement, human errors prevention, metrology, testing, diagnostics, QFD, categorical data

QUEUEING SYSTEMS

Rachel Ravid and **David Perry** (University of Haifa)

This research focuses on performance analysis of priority queuing systems. It assumes that the systems are in a steady state, and the aim is to find the steady state probabilities and the customer sojourn time distribution.

Keywords: Queuing systems, renewal processes, priority queues

RISK MANAGEMENT

Meir Tahan, **Tsvi Kuflik** (University of Haifa), and **Efrat Yuval** (University of Haifa)

Development and deployment programs continue to suffer from budget overruns, schedule delays and poor technical performance, in most cases as a result of failure in handling uncertainty in complex software system development. Development communities lack a systematic method for identifying, communicating and resolving technical uncertainty. This research focuses on the risk identification stage and tries to understand the reasons for unidentified risk appearing during project development by interviewing project managers working in industry. The findings suggest that the unidentified risk factors can be divided into three main types: managerial, behavioral and external. Each category consists of factors which, through the awareness and openness of project teams and managers, can help avert many problems and achieve project success.

Keywords: Risk identification, unidentified risks, uncertainty

ROBUST FACILITY LOCATION AND CAPACITY PLANNING

Hussein Naseraldin and **Opher Baron** (University of Toronto)

A facility refers to a retail outlet, service depot, or production plant. In all cases, facility planning involves determining how many facilities to open so as to cover a demand created in a specific area. It also involves determining the location of each facility. By determining these two decisions, we fix most of the supply chain network structure. Several approaches to making these decisions are possible. Among others, a robust optimization approach guarantees solutions that are robust to changes in the parameters due to uncertainty, in particular, uncertainty in demand.

Keywords: Number of facilities, network design, distance metric, robust optimization

ROBUST SCHEDULING

Hussein Naseraldin and **Boris Shnits**

Scheduling in service is an important operation. If uncertainty exists, robust optimization is a valid approach to adopt. While uncertainty can stem from various sources, the processing time is

a major factor. This paper focuses on modeling and solving a scheduling problem in a hardware department that receives several requirements for board development. Two types of resources are at hand: designer and layout. Several tasks are performed by each resource. The problem is to minimize the total tardiness of all boards. A major challenge in such an environment is the fact that the due date of the jobs, i.e. the boards, are on the critical path of the larger system development. Thus, improvement in the performance of board development will have an impact on the system's performance.

DUE DATE ASSIGNMENT (DDA) PROBLEM

Hussein Naseraldin, **Liron Yedidsion** (Technion—Israel Institute of Technology), and **Chen Bukay** (Technion—Israel Institute of Technology)

Scheduling is a crucial aspect of operations control, whether in manufacturing or in service. The decision-maker faces various types of scheduling problems. Among others, there is the Due Date Assignment (DDA) problem, where the objective is to minimize costs by examining the resulting delivery time of each scheduled job. Additional reasons for delay in delivery time include a broken machine, a machine being configured, and a newly hired operator exploring his learning curve. The problem is exacerbated if the uncertainty is related to other types of data for which there is no previous experience or historical data set. To cope with this limitation, robust optimization (RO) is emerging as a promising methodology to incorporate uncertainty in the decision-making process, when not relying on full probabilistic information. This research proposal utilizes robust optimization of model scheduling problems to derive efficient solutions for these scheduling problems.

Keywords: Robust optimization, scheduling, due-date assignment

STAFFING EFFECTIVENESS AND THE ROLE OF NATIONAL INSTITUTIONS

Hilla Peretz, **Lena Knappert** (Tilburg University, The Netherlands), **Zeynep Aycan** (Koc University, Turkey), and **Pawan Budhwar** (Aston University, UK)

In today's global rivalry for talent, multinational and domestic organizations compete for the best candidates and are concerned with how to design and implement staffing activities that fit the global and the local contexts. However, most studies on this topic show a tendency to occur in a vacuum with a disproportionate emphasis on individual-level validity, seemingly oblivious to the surrounding world and context. This study, built on neo-institutional theory, develops a multi-level conceptual model that captures the impact of national institutions on staffing practices, the effect of these institutionally-embedded staffing practices on organizational outcomes, and the influence of institutional pressure (i.e. tight vs. loose social norms) on these relationships.

SERVICE DESIGN WITH APPLICATION TO EMERGENCY DEPARTMENT SYSTEMS

Tamar Gadrich, **Shuki Dror**, and **Yariv Marmor**

To handle problems and trends in emergency department (ED) operations, designers and decision makers simulate and evaluate various scenarios before testing them in a real-life environment. Conceptualizing broad possible scenarios for ED operations prior to simulation, however, is usually neglected. This paper suggests a framework for the schematic conceptual development of these scenarios.

The application of the methodology is illustrated in a specific ED. It contributes to the area of ED computer simulation by suggesting a methodology that offers the following advantages: (1) Simulation scenarios that can be schematically formulated rather than based on trial-and-error experiments; and (2) Scenario development that can be integrated in the different stages of simulation model development to support designers and management in understanding ED problems, improvement goals, the data that should be collected, and the operational changes that should be applied.

Keywords: Simulation, design of experiments, conceptual modeling, scenarios, emergency department

SMART GRID OPERATIONS MANAGEMENT

Hussein Naseraldin and **Liron Yedidsion** (Technion—Israel Institute of Technology)

Technology development has led to a new electricity network type, called the Smart Grid. The basic notion behind the Smart Grid concept is to improve the overall efficiency of electricity production, delivery, and consumption, while increasing the reliability and security of the electrical grid. Deviations in electricity consumption rates throughout the day lead to different electricity pricing schemes. Assuming that consumers (individuals and businesses alike) adapt to the pricing schemes by postponing usage of some electrical devices until off-peak periods, costs will be reduced. Furthermore, the electricity provider will benefit, as the demand at peak periods will be leveled and capacity requirements will balance out over time. Smart Grid operation management involves the determination of related decisions using operation management and operation research tools and methodologies.

Keywords: Smart grid, lot-sizing, algorithm complexity

ADDITIVE MANUFACTURING FOR RESILIENT SUPPLY CHAIN

Hussein Naseraldin and **Atanu Chaudhuri** (Alborg University, Copenhagen, Denmark)

The adoption of Additive Manufacturing (AM) across industries has increased significantly in recent years due to the faster pace of development of underlying technologies and companies recognizing its potential. As the barriers for adopting additive manufacturing are overcome, the technology has the potential to fundamentally change how products are designed and

developed, produced, delivered and serviced. AM thus requires a significant redesign of the external supply chain structure around a company and the internal processes within new product development, manufacturing, order fulfillment, spare parts delivery, and logistics within a company. In the near future, products will be manufactured using a combination of both traditional manufacturing technologies and AM. But small and medium suppliers who currently use traditional manufacturing technologies find it difficult to overcome the design, manufacturing, and supply chain related challenges associated with adoption of AM. This research explores various aspects of integrating AM in the regular manufacturing arena.

Keywords: Industry 4.0, Additive Manufacturing, 3D printing

SUPPLY CHAIN AND INDUSTRY 4.0

Hussein Naseraldin, **Atanu Chaudhuri** (Alborg University, Copenhagen, Denmark), **Yuval Cohen** (Tel Aviv Afeka College of Engineering, Israel), **Francesco Pilati** (University of Bologna, Bologna, Italy), and **Xavier Brusset** (Skema Business School, France)

Industry 4.0 is about the adoption of new technologies in the industrial arena. The major technology, called Industrial Internet of Things (IIoT), includes massive transformation in digitization and communication between the industrial shop floor and the digital world. Assembly lines and assembly systems are a major echelon in the value chain of many products, and are related to the coupling of various parts. However, in the era of Industry 4.0, the parts can communicate with each other while data is constantly being gathered. In a broader view, the supply chain will be affected as well. Things will be connected along the supply chain, and decision-making and reasoning abilities will be enabled. Also, a disrupting technology like blockchain is more likely than ever to alter the way we view the value chain, structure-wise and operation-wise. This research explores the impact of the IIoT on three levels: strategic, tactical, and operational.

Keywords: Smart manufacturing, Industry 4.0, Assembly 4.0

SUPPLY CHAIN DESIGN AND MANAGEMENT

Hussein Naseraldin

The main objective of supply chain management is to achieve operational excellence across all aspects of a firm. This can be achieved by maximizing the value created by each and every decision and operation. This optimization results in superior performance, which leads to an increasing market share with satisfied customers. To achieve this, all decisions must be aligned and integrated. That is, operational decisions must be taken into consideration when making strategic decisions. Among the most important strategic decisions in a supply chain context are the number and location of facilities.

Keywords: Supply chain design, network configuration, multi-echelon, supply chain performance

SYSTEM INTEGRATION

Meir Tahan

Engineering system integration presents a multiplicity of challenges. Among other things, different disciplines must be balanced, the work of several teams must be coordinated, and the issue of units that are necessary but not available on time must be handled. Special test equipment must be designed, hubs and stubs must be prepared, and risks that are liable to occur during integration must be assessed and prevented. All these problems and difficulties result in schedule delays and unplanned expenses.

This paper presents a structured methodology for building an integration preparation plan and thereafter guiding the actual integration. The methodology is based on the "V" model for systems engineering. The left side of the "V" represents the design stage and the right side represents the integration stage. The "looking forward" methodology follows the development steps, and at each step looks forward to the relevant integration step, anticipating what may be required for successful integration. This action creates versatile integration tools that are sufficiently flexible to absorb unexpected variations in the project.

Keywords: System integration, testing, verification, validation

INTEGRATION PLAN

Meir Tahan and **Roy Benish** (HTS – High-Tech Solutions)

An integration plan is usually prepared intuitively by experienced engineers based on their previous experience and on project constraints. Since this plan is intuitive, it may not be optimal. The integration process involves severe uncertainties such as units not being available on time, integration increment duration, and testing costs. Many times, such uncertainties cause changes in the project plan. The integration team members may find themselves unprepared for these changes,again because the integration plan is not optimal. This research offers a model-based software tool for finding an optimal path for system integration. The tool finds the optimum path, assuming deterministic integration parameters or parameters with inherent uncertainties. The tool is designed for project managers, integration teams, and academic integration research. It has built-in flexibility to serve a variety of organizations and users.

Keywords: System integration, integration plan, integration tool

EFFECT OF FEEDBACK ON IMPROVING VISUAL ATTENTION SKILLS

Nirit Gavish and **Hagit Krisher** (ORT Braude College – Students' Support Center)

A common cause of reading disorders is visual attention deficit. Research has demonstrated that training using a dedicated training program and protocol can improve visual attention skills and reading abilities. The common method is based on exposing trainees to slow, smooth pursuit tracking of fragmented stimuli. This gradual exposure enables the trainees to acquire

visual attention skills. Until now, however, training was based solely on bottom-up processes and higher-level cognitive inferences; top-down processes were not considered. The current research examines whether adding controlled feedback to the training protocol can support top-down processes, which, in combination with bottom-up processes, will facilitate learning and skill transfer.

Keywords: Training, visual attention, reading, bottom-up, top-down

USE OF SERIOUS GAMING TO IMPROVE INTELLIGENCE ANALYSIS

Doron Faran and **Nirit Gavish**

The quality of intelligence analyses depends on the analysts' skills. Even though training programs supported by e-learning have shown progress, the creative reasoning skills and reflexes of law enforcement agents are not completely optimized. This research focuses on understanding how analysts use both deduction and induction in their thinking, seeking ways to help them fully exploit their skills, knowledge, experience, and creativity. A computerized training program that addresses the major training needs of analysts will be developed, and the serious gaming approach will be used for this training program.

Keywords: Intelligence, serious gaming, training, analysis

WATER QUALITY FUNCTION DEPLOYMENT

Natalia Zaitsev and **Shuki Dror**

Access to a reliable source of potable water is essential for the survival of human life and almost all living organisms. Technological advancements in recent decades have generated a variety of interchangeable methods for improving water quality. This study seeks to create a framework to facilitate the selection of the right technology by a water supplier aiming to improve the quality of tap water being supplied. A structured methodological approach based on Quality Function Deployment (QFD) is presented. This process extracts the desired improvements in water quality (as identified by its users through a questionnaire) and translates them into the required technical improvements, and ultimately, into core technologies ranked by importance. In constructing the water QFD, two matrices representing questionnaire results were analyzed. Normalized improvement scores were calculated at each of three hierarchical levels: customer requirements, technical parameters, and technologies. The components to improve at each level were selected using analysis-of-variance (ANOVA). The methodology for selecting relevant technologies for improving tap water quality was implemented in the Galilee region in Israel.

Keywords: Quality function deployment, tap water quality, importance of technology

OPTIMAL CONTROL OF A TWO-SERVER FLOW-SHOP NETWORK

Yossef Luzon (Tel Aviv University), **Yariv Marmor**, and **Eugene Khmelnitsky** (Tel Aviv University)

This paper suggests a new, intuitive, and simple method for scheduling jobs in a two-server flow-shop network (FSN) with a minimum makespan objective. Multiple types of jobs with corresponding constant service times arrive at the network at various times over a finite time interval. An analog fluid network is proposed, and its optimal fluid control policy determined. This paper makes use of this optimal control policy to suggest a new method for scheduling jobs in the original discrete FSN and prove its asymptotic optimality. The method is particularly attractive because it falls into the class of easy-to-implement and computationally inexpensive online algorithms. Numerical simulations are used to evaluate the performance of the suggested method and show that it performs optimally in almost all simulated instances. Some additional properties of the network are discussed and illustrated.

Keywords: Flow-shop network, scheduling policy, tandem fluid network, optimal control, fluid-based queueing discipline

OPTIMIZATION AND SIMULATION OF ORTHOPEDIC SPINE SURGERY CASES AT MAYO CLINIC

Asli Ozen (University of Massachusetts Amherst), **Yariv Marmor**, **Thomas Rohleder** (Mayo Clinic), **Hari Balasubramanian** (University of Massachusetts Amherst), **Jeanne Huddleston** (Mayo Clinic), and **Paul Huddleston** (Mayo Clinic)

Spine surgeries tend to be lengthy (with a mean time of four hours) and highly variable (with some surgeries lasting 18 hours or more). This variability, along with patient preferences motivating scheduling decisions, has resulted in both low operating room (OR) utilization and significant overtime for surgical teams at the Mayo Clinic. This paper discusses the development of an improved scheduling approach for spine surgeries over a rolling planning horizon. First, data mining and statistical analysis were performed using a large data set to identify categories of surgeries that could be grouped together based on surgical time distributions and could be categorized at the time of case scheduling. These surgical categories are then used in a hierarchical optimization approach with the objective of maximizing a weighted combination of OR utilization and net profit. The optimization model is explored to consider trade-offs and relationships among utilization levels, financial performance, overtime allowance, and case mix. The new scheduling approach was implemented via a custom web-based application that allowed the surgeons and schedulers to identify the best surgical days interactively with patients. A pilot implementation resulted in a utilization increase of 19% and a reduction in overtime of 10%.

Keywords: Operating room scheduling, surgery scheduling, mixed-integer program

INPATIENT FLOW IN HOSPITALS: A DATA-BASED QUEUEING-SCIENCE PERSPECTIVE

Mor Armony (New York University), **Shlomo Israelit** (Rambam Healthcare Campus), **Avishai Mandelbaum** (Technion—Israel Institute of Technology), **Yariv N. Marmor**, **Yulia Tseytlin** (IBM Research), and **Galit B. Yom-Tov** (Technion—Israel Institute of Technology)

Hospitals are complex systems with essential societal benefits and huge mounting costs. These costs are exacerbated by inefficiencies in hospital processes, which are often manifested by congestion and long delays in patient care. Thus, a queueing-network view of patient flow in hospitals is natural for studying and improving performance. The goal of the research is to explore patient flow data through the lens of a queueing scientist. The means is exploratory data analysis (EDA) in a large Israeli hospital, which reveals important features that are not readily explainable by existing models. Questions raised by the EDA include these: Can a simple (parsimonious) queueing model usefully capture the complex operational reality of the Emergency Department (ED)? What time scales and operational regimes are relevant for modeling patient length of stay in the Internal Wards (IWs)? How do protocols of patient transfer between the ED and the IWs influence patient delay, workload division, and fairness? EDA also underscores the importance of an integrative view of hospital units, by, for example, relating ED bottlenecks to IW physician protocols. The significance of such questions and the related findings raise the need for novel queueing models and theory, which are presented here as research opportunities. Hospital data, and specifically patient flow data at the level of the individual patient, is increasingly collected but is typically confidential and/or proprietary. We have been fortunate to partner with a hospital that gives all the research partners access to its data. This enables reproducibility of the findings through a user-friendly platform that is accessible via the Technion's SEELab.

Keywords: Hospitals operation, queueing network, exploratory data analysis (EDA), emergency department, internal ward

AN APPOINTMENT SCHEDULING POLICY FOR HEALTHCARE SYSTEMS WITH PARALLEL SERVERS AND PRE-DETERMINED SERVICE LEVELS

Boris Shnits, **Illana Bendavid**, and **Yariv N. Marmor**

The appointment scheduling problem is well-known in the literature. The use of appointment systems has been adopted widely in many different fields, including service industries and especially healthcare. This research focuses on healthcare systems where patients arrive according to pre-assigned appointments. We consider healthcare systems with several parallel servers, where a given sequence of patients, with randomly distributed service durations and a possibility of no-shows, is to be scheduled. The aim is to minimize the end of day and increase resource utilization while requiring a minimal probability of each appointment starting on time (quality of service). We formulated the problem using mathematical programing and developed a multi-server numerical-based (MSN) algorithm to solve it. We conducted experiments and checked the impact of the problem parameters on the end of day, customers' average waiting time, and the percentage of customers that waited for service, showing how server pooling improves the above system measures. Once the appointments are set, a methodology determines the shift

length to balance overtime costs (costs of overtime hours) against under-time costs (costs of regular, unused hours).

Keywords: Optimization, appointment scheduling, healthcare systems, service levels, simulation

ABRUPT CHANGE OF PROCESS BEHAVIOR: THE ANDERSON-DARLING DETECTION TOOL

Yariv N. Marmor and **Emil Bashkansky**

A manufacturing process must be stable to produce a quality product. When a process-stabilizing factor fails, the behavior of process data, which should indicate a change has occurred, also changes. This change may be discovered by different methods, among which the Anderson-Darling (AD) method has certain advantages—when the change relates to the nature/shape of the data distribution and while location and scale parameters remain unchanged. The authors propose a method of change point detection, based on tracking the maximal contrast between AD statistics before and after the sliding time point inside a moving data window. For the purpose of easy and effective use of the proposed method, a free access auxiliary Excel™ program tool was developed. Performance of the proposed method is studied, and two illustrative examples of its application are presented. The proposed tool can be used both for online and offline data processing.

Keywords: Change point estimation, fault detection, goodness-of-fit methods, process monitoring, simulation modeling

PATIENT DIAGNOSTIC STATE EVOLUTION DURING HOSPITALIZATION: DEVELOPING A MODEL FOR MEASURING CLINICAL DIAGNOSTIC DYNAMICS

Yariv N. Marmor and **Emil Bashkansky**

Patient health is represented by a set of diagnoses, which determines personal health status. Each set corresponds to a certain health state and can be treated as an individual performance in this state, so individual health can be considered as a corresponding multi-state system. Appropriate metrics for measuring patient's state diagnosis changes during hospitalization are proposed. The first metric determines the dissimilarity between two single diagnoses, each of which is based on an internationally recognized classification scheme. The second metric aims to compare two sets of diagnoses with respect to the same patient and is based on the first metric, but uses additional, recently proposed ideas of measuring heterogeneity/segregation between sets of categorical data. A numerical example and a real-world illustration of the above measures are provided. The ultimate goal is the analysis of multi-state health status data to improve the accuracy and quality of medical diagnostics.

Keywords: Medical diagnosis, accuracy, misclassification, dissimilarity, healthcare quality

MINIMUM FLOW TIME IN A TANDEM TWO-SERVER FLUID NETWORK

Yossef Luzon (Tel Aviv University), **Yariv Marmor**, and **Eugene Khmelnitsky** (Tel Aviv University)

This research considers a tandem, two-server fluid network with two fluid types. Each server in the network has two buffers, one for each fluid, and the capacity of each server can be shared among the fluids. An initial amount of fluids is to be processed by both servers and drained through the system. We determine the processing rates for which the servers' capacity is optimally shared, with the objective of minimizing the total flow time. Three cases of the optimal strategy are discussed.

Keywords: Fluids, servers, optimal control, stochastic processes, closed-form solutions, complexity theory, approximation algorithms

DEVELOPING AN OPTIMAL APPOINTMENT SCHEDULING FOR SYSTEMS WITH RIGID STANDBY TIME UNDER PRE-DETERMINED QUALITY OF SERVICE

Illana Bendavid, **Yariv N. Marmor**, and **Boris Shnits**

A critical step in patient care path is diagnosis. The demand for advanced imaging tests such as computerized axial tomography (CAT) scans, magnetic resonance imaging (MRI), and positron emission tomography (PET) has increased dramatically in the past 15 years. Since imaging equipment remains relatively expensive, to fit the demand, the imaging resources must be managed effectively while ensuring required quality of service. In PET, a radiopharmaceutical (radioactive substance) is injected into patients prior to their scans. The time between substance injection and scan (standby or uptake time) is rigid. This constraint makes the patient appointment scheduling more challenging, because if at the end of the expected uptake time the scanner is not available, the quality of the scan is jeopardized (due to the short half-life duration of the substance). The availability of the scanner is a consequence of prior scan appointments and durations. The aim of this work is to develop an approach for appointment scheduling in a system with one scanner, given a sequence of patients and rigid uptake time, to minimize the length of day while satisfying a minimal predetermined quality of service. To solve this stochastic problem, we formulate its equivalent deterministic problem, based on simulated data, as mixed-integer linear programming. To overcome the dimensionality limitations, a simulation-based sequential algorithm solves the problem in a reasonable time. A fixed slot per scan policy, as a benchmark, is inferior to this method, especially in achieving stable and fair quality of service for patients.

Keywords: Optimization, appointment scheduling, healthcare systems, quality of service, simulation

SOME METROLOGICAL ASPECTS OF PREFERENCES EXPRESSED BY PRIORITIZATION OF ALTERNATIVES

Amalia Vanacorea (University of Naples Federico II), **Yariv N. Marmor**, and **Emil Bashkansky**

With the growth of industrial process sophistication, new horizons have opened up for modern metrology. This research focuses on metrological aspects of multi-agent assessment, expressed by

prioritization. Specifically, it examines the case of a group of agents expressing their preferences over a fixed set of alternatives by means of weak orders. Preference chains are compared via simple distance metrics based on cosine similarity. Following a metrological approach, the agents' precision in performing prioritization tasks is evaluated in terms of repeatability and reproducibility. This is done by analyzing the preference variations in different trials of the same prioritization task and among different agents involved in the prioritization process. The paper introduces a median concept for aggregating multi-agent preference orderings to obtain a collective solution. The proposed strategy is illustrated through a case study of consumers expressing their preferences regarding a set of alternatives. Further research opportunities are also discussed.

Keywords: Assessment; preference chain; distance metric; repeatability; reproducibility; decisions fusion

THE RELATIONSHIP BETWEEN INDUSTRIAL ENGINEERING AND MAIN PHYSICAL CONCEPTS

Boris Shnits and **Emil Bashkansky**

The teaching of physics, a basic discipline studied by undergraduate industrial engineers, usually focuses on content, and unfortunately, to a much lesser extent, on general concepts and ideas that are important for a modern industrial engineer. The authors present twelve key physical concepts, which in their view and experience are crucial to the education of intelligent and proficient industrial engineers. The authors provide arguments supporting the direct and indirect relationship between these concepts and the practice of industrial engineering. They emphasize the expediency in adjusting the existing approach to teaching physics to include these concepts, thereby aligning it with modern industrial engineering needs on the eve of the fourth industrial revolution.

BINARY TEST OF LATENT ABILITY: EVALUATION & DESIGN PROBLEMS

Emil Bashkansky and **Vladimir Turetsky**

In recent years, substantial progress in the analysis and interpretation of binary test results has been achieved. This is the simplest issue of unidimensional ability, when the test item performance of the object under test (OUT) can be explained by a single latent ability. The test consists of a set of K test items, where every test item response is estimated on the binary scale basis (pass/fail) and we need to evaluate the intrinsic ability of this OUT. Usually, it is assumed that the results of different test items, applied to the same OUT, are conditionally independent (i.e. the response to one test item does not affect the response to another). Given a specific item response function (IRF) model, assessment of the tested ability usually is produced according to the principle of maximum likelihood estimation (MLE) or on the basis of a Bayesian approach (if some preliminary information about the tested ability exists). When levels of test item difficulties

are known beforehand, the problem solution is relatively easy, but when the number of OUTs is bounded and levels of difficulties are unknown beforehand, analysis of the results faces significant computational difficulties. Nevertheless, in principle, the problem is solvable. However, when we consider how to optimally allocate test resources — that is, how to choose the level of test item difficulties, how many repetitions to perform for every level, what is the criterion of optimality, etc.— we come to terra incognita. The research is an attempt to describe possible approaches to and criteria for the test planning problem, rather than its complete solution. We also treat some real applications of the proposed approach in education and antagonistic games.

CONFERENCES, WORKSHOPS, & SEMINARS

THE ANNUAL GALILEE QUALITY CONFERENCE
Karmiel, Israel; June 2016, May 2018
http://www.braude.ac.il/conferences/quality16/
http://www.braude.ac.il/conferences/quality18/

The IE&M Department conducted 25 research-oriented seminars during 2016-2018.

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T. Gadrich and **H. Katriel,** A mechanistic stochastic Ricker model: Analytical and numerical investigations. *International Journal of Bifurcation and Chaos, 26*(4), 2016.

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E. Bashkansky and V. Turetsky, Binary test of latent ability: Evaluation and design problems, *18th Annual European Network for Business and Industrial Statistics (ENBIS) Conference*, Nancy, France, 2–6 September, 2018.

S. Dror, *18th Annual European Network for Business and Industrial Statistics (ENBIS) Conference*, Nancy, France, 2-6 September 2018.

S. Dror, *Performance Measurement and Management (PMA*) *Conference*, Warsaw, Poland**,** 23-26 September 2018.

H. Peretz, Employee reactions to HPWS in multinational companies: Effects of Subsidiary and Parent Cultures. Presented at the Academy of Management, August, Chicago, IL, USA, 2018.

E. Bashkansky and V. Turetsky, Binary test design problem, *International Conference Advanced Mathematical and Computational Tools in Metrology and Testing*, Glasgow, UK, August 2017.

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Y. Marmor, *17th Annual European Network for Business and Industrial Statistics (ENBIS) Conference*, Naples, Italy, 9–14 September, 2017

H. Peretz, Addressing the challenges of large scale, cross-national survey data collection. Presented at the Academy of Management, Atlanta, GA, USA, August 2017.

H. Peretz, Generation Y and work values: Are they really that different? A cross-cultural examination using data mining of social networks. Presented at the Global Conference of International HRM, New York City, USA, May 2017.

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OTHER PUBLICATIONS

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H. Peretz, *Generation Y and work values: A cross-cultural examination using data mining of social networks*, (*SHRM Foundation*), Principal Investigator. Joint grant with Y. Fried and E. Parry, 2015-2017.

JOURNAL EDITORIAL BOARD

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German Journal of Human Resource Management

JOURNAL REFEREES

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Computers and Industrial Engineering
Central European Journal of Operations Research

H. Peretz
European Journal of Work and Organizational Psychology
International Organizational Performance
Leadership Quarterly
Human Resource Management Journal

B. Shnits
International Journal of Production Research

Y. Marmor
Omega: The International Journal of Management Science
EJOR (European Journal of Operational Research)
IISE (Institute of Industrial and Systems Engineers) Transactions
Applied Mathematics and Computation Journal
Journal of the Operational Research Society
MSOM (Manufacturing and Service Operations Management Society) Conference
Israeli Industrial Engineering & Management Conference
WSC (Winter Simulation Conference)

INTERNATIONAL COOPERATION

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Academy of Management HR Division Ambassadors Program, Israel Representative.
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COST (European Corporation of Science and Technology) management committee member, Action IS1202, Dynamics of Virtual Work.

DOCTORAL EXAMINATION

E. Bashkansky
2018 – Maria Sole Pellegrino (University of Naples Federico II, Scuola Politecnica e Delle Scienze Di Base, Ph.D. thesis: Assessing and inferring intra and inter-rater agreement).
2016 – Thomas Akkerhuis (University of Amsterdam, Amsterdam Business School Research Institute, Ph.D. thesis: Measurement system analysis for binary tests).

Y. Marmor
2018 – Maria Sole Pellegrino (University of Naples Federico II, Scuola Politecnica E'Delle Scienze Di Base, Ph.D. thesis: Assessing and inferring intra and inter-rater agreement).
2017 – Nitzan Carmeli (Technion**—Israel Institute of Technology**, Ph.D. Candidate).

Department of Mathematics & Applied Mathematics

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RESEARCH AREAS

ALGEBRA

Abed Abedelfatah, Mark N. Berman, Crystal Hoyt, Ofir Schnabel, Yuval Ginosar (University of Haifa), **Leo Margolis** (Vrije Universiteit Brussel), **Alexey Gordienko** (Vrije Universiteit Brussel), **Eran Nevo** (Hebrew University of Jerusalem), **Michael Schein** (Bar-Ilan University), **Uri Onn** (The Australian National University), and **Benjamin Klopsch** (Heinrich-Heine-Universitaet Düsseldorf)

The research group in algebra has two broad areas of interest. One area concerns classical questions in algebra. These include twisted group algebras as a tool for understanding algebraic concepts such as simply-graded algebras and units of (twisted) group rings, and the so-called isomorphism problems for (twisted) group rings. Further classical topics include the Hilbert function of graded algebra, Betti numbers of monomial ideals, and face numbers of simplicial complexes. The second broad area of interest is in Lie algebras, Lie superalgebras, and the subgroup growth of finitely generated groups. A unifying theme in all of our work is the application of methods from other branches of mathematics to develop algebraic theories. Especially prominent here are representation theory and combinatorial methods. Representation theory is of independent importance as a tool in many areas of mathematics and science. This connects us to the scientific community at large.

Keywords: Lie algebras, Lie superalgebras, representation theory, Hilbert functions, Betti numbers, regular sequences, simplicial complexes, graded ideals, graded algebras, twisted group rings, projective representations, groups of central type, finitely generated nilpotent groups, zeta functions of groups, pro-isomorphic zeta functions, algebraic groups, p-adic integration

CONTROL THEORY, DIFFERENTIAL GAMES AND OPTIMIZATION

Aviv Gibali, Valery Y. Glizer, Vladimir Turetsky, Emilia Fridman (Tel Aviv University)**, Leonid Fridman** (National Autonomous University of Mexico), and **Galina A. Kurina** (Voronezh State University, Russia)

Control theory examines ways to manipulate input to a dynamic system in order to obtain desired behavior and output.

Optimization theory focuses on finding a best element with respect to some criterion, from a set of alternatives. Many real-world problems are modeled as either single- or multi-objective optimization. The theory consists of the existence of solutions and the development of iterative methods for finding one or several equivalent solutions.

Prof. Gibali's research focuses on mathematical theory and the development of iterative algorithms for solving feasibility problems and their applications to industrial problems such as Radiation Therapy Treatment Planning and Image Processing.

Prof. Glizer's research focuses on control problems and differential games with singularly perturbed dynamics; cheap control problems; singular control problems; robust control problems; differential games with perfect and imperfect information; differential games with hybrid dynamics; singular differential games; multi-objective differential games; singularly perturbed ODE and PDE, functional-differential equations; difference equations; non-linear stochastic differential and difference equations; nonlinear theory of generalized functions and its applications.

Prof. Turetsky is engaged in studying pursuit-evasion games with perfect and imperfect information; robust control; generalized linear-quadratic games; optimal control; cheap control problems; differential games with hybrid dynamics; invariant sets for feedback strategies; inverse problems of signal restoration, and differentiation.

Keywords: Feasibility problems, control design, non-cooperative and antagonistic games, single- and multi-objective optimization, real-world problems

DYNAMICAL SYSTEMS AND NONLINEAR ANALYSIS

Mark Elin, Fiana Jacobzon, Haggai Katriel, **Marina Levenshtein, Filippo Bracci** (Universitá di Roma "Tor Vergata", Italy), **Manuel D. Contreras** (Universidad de Sevilla), **Santiago Díaz-Madrigal** (Universidad de Sevilla), **Lawrence Harris** (University of Kentucky, USA), **Jurii Kozicki** (University of Maria Curie-Sklodowska, Poland), **Tadeusz Kuczumov** (University of Maria Curie-Sklodowska, Poland), **Simeon Reich** (Technion–Israel Institute of Technology), and **David Shoikhet (Holon Institute of Technology)**

The interest of mathematicians in the general theory of dynamical systems dates back to the early 20th century. Our research focuses on fixed point theory, operator and resolvent methods, and their application to autonomous and non-autonomous differential equations. A question of central interest is to classify certain families of holomorphic mappings in a Banach space with respect to conjugacy. We also study the asymptotic behavior of discrete and continuous time semigroups and semicocycles (in one-dimensional and multi-dimensional settings), and

boundary rigidity problems for semigroups and their generators. We are also interested in criteria of analytic extension of semigroups with respect to their parameter.

Keywords: Semigroups and semicocycles, infinitesimal generator, filtration of generators, nonlinear resolvent, analytic semigroups, asymptotic behavior

GEOMETRIC FUNCTION THEORY / COMPLEX ANALYSIS

Mark Elin, Fiana Jacobzon, , **Marina Levenshtein, Vladimir Bolotnikov** (College of William and Mary, USA)**, Ronald L. M. Lui** (The Chinese University of Hong Kong), **Alexander Naitsat** (Technion–Israel Institute of Technology), **David Shoikhet (Holon Institute of Technology), Toshiyuki Sugawa (Tohoku University, Sendai, Japan)**, **Nikolai Tarkhanov** (Universität Potsdam, Germany), **Nikola Tuneski** (**Ss. Cyril and Methodius University, Skopje, Republic of Macedonia), and Yehoshua Y. Zeevi** (Technion–Israel Institute of Technology)

Geometric function theory, which focuses on the geometric properties of univalent mappings, has been an active field for over a century. Well-known results in this field include the Riemann mapping theorem, hyperbolic geometry, the Schwarz-Pick Lemma and its boundary versions.
Our research focuses on biholomorphic mappings on a unit ball in one-dimensional and multi-dimensional complex spaces. We study the geometric structure of these mappings, including star-like and spiral-like mappings, with respect to an interior point or a boundary point, convex functions in one direction, and so on. Geometric characteristics of images involve distortion and covering theorems, and boundary behavior of different classes of mappings, as well as interpolation problems.
Another field of study is quasiconformal and quasiregular mappings, which are both of theoretical interest as generalizations of conformal mappings, and of applied interest, as they arise naturally in the context of Computer Graphics and Imaging, in particular, in Medical Imaging.

Keywords: Starlike, spirallike functions, distortion theorems, boundary behavior, quasiconformal and quasiregular mappings, dilation, Imaging

GEOMETRY AND ITS APPLICATIONS

Emil Saucan, Eli Appleboim (Technion–Israel Institute of Technology), David X. Gu (Stony Brook University, USA), Jürgen Jost (Max Planck Institute for Mathematics in the Sciences, Leipzig), Na Lei (Dalian University of Technology, China), Areejit Samal (Institute of Mathematical Sciences, Chennai, India), and Melanie Weber (Princeton University, USA)

Geometry, the study of shape and space, is one of the central fields of mathematics. Among its variety of subfields, one that has recently become very active is Discrete Differential Geometry, both due to its intrinsic beauty and because of its many applications in Computer Graphics, Imaging, Computer Aided Design, Complex Networks and Pattern Recognition. In particular, we study discrete Ricci curvature and flows, and their applications to Complex Networks, Imaging, and Deep Learning, which have proven to be very fruitful. The role of discrete Ricci curvature

in Medical Imaging, mainly for anomaly detection in CT and MIR images, is another promising direction of study.

Keywords: Discrete Ricci curvature and flow, Forman Curvature, Ollivier Curvature, Complex Networks understanding and long-time evolution, anomaly detection in medical images.

MATHEMATICAL EDUCATION

Buma Abramovitz, Miryam Berezina, Ludmila Shvartsman, Fiana Yacobzon, Abraham Berman (Technion–Israel Institute of Technology), and **Boris Koichu** (Technion–Israel Institute of Technology)

The main purpose of this research is to develop methods for teaching mathematics at the undergraduate level in order to improve students' understanding.

Keywords: Mathematical education, understanding, undergraduate level

PARTIAL DIFFERENTIAL EQUATIONS AND APPLICATIONS TO NATURAL SCIENCES

Yaniv Almog, Jorge Berger, Ofer Eyal, Tamar Gadrich, Lavi Karp, Haggai Katriel, Yakov Lutsky, and Victor Ostrovski

Mathematical models are important tools in the effort to understand the behavior of complex systems in all branches of science. We use mathematical analysis to study such models in order to shed light on the natural phenomena that they describe. Partial differential equations (PDEs) are central for modeling physical phenomena. Work on PDEs began in the eighteenth century, motivated by fluid mechanics, wave motion, and electromagnetism. Since that time, the range of applications of PDEs has expanded rapidly, and nowadays PDEs are applied in quantum mechanics, general relativity, geometry, as well as in other fields such as mathematical biology and financial mathematics. The group's research deals with several aspects of this vast field.

Einstein equations describe the evolution of matter and energy in a curved spacetime. We are interested in Euler-Einstein systems; that is, the Einstein field equations coupled with the relativistic Euler equations of compressible fluid. The non-relativistic version is the Euler-Poisson equations. Non-linear hyperbolic PDEs are the main tool to investigate those systems.

Free boundary problems are concerned with solutions of differential equations whose boundary is unknown in advance. We are interested in the free boundary problems that arise from potential theory and Hele-Shaw flows.

The study of hydrodynamic stability explores the transition to weak turbulence of steady flows. As has been observed in numerous experiments, when the steady flow loses its stability, the flow becomes time-dependent and vortex motion appears. We focus our interest on linear stability analysis of incompressible laminar flows. While it is commonly agreed that the transition to turbulence results from non-linear effects, the properties of the linearized Navier-Stokes operator play a significant role in the non-linear stability analysis.

Mathematical biology involves the study of dynamical systems relevant to biological phenomena, at different levels: from the subcellular level (biochemical kinetics, gene regulation), through the level of the organism (physiological processes, inter-host dynamics of infections, cancer), up to the level of populations (ecology, epidemiology, population genetics, and evolution).
We are interested in theoretical and mathematical investigation of dynamic models, in formulation of new models, and in fitting mathematical models to experimental, clinical, and epidemiological data, using modern statistical methods.

Keywords: Mathematical modeling, Partial Differential Equations, Euler-Einstein systems, free boundary problems, mathematical biology, ecology, epidemiology, hydrodynamic stability

CONFERENCES, WORKSHOPS & SEMINARS

The Workshop on Operator Theory and Applications

September, 2016

http://braude.ac.il/conferences/workshop_on_operator_theory_and_applications/

The workshop was held in the framework of the STREVCOM project. The workshop's aim was to present recent research on

- Applications of Operator Theory to interacting particle systems
- Spectral Theory
- Semigroups of Composition Operators

and to exchange ideas to promote discussion and collaboration, especially in the forum of STREVCOM's participants.

The First Joint IMU-INdAM Conference in Analysis

May – June, 2017

http://golberga.faculty.hit.ac.il/IICA17/IICA17.html

This joint event of the Israeli Mathematical Union and the Istituto Nazionale di Alta Matematica "F. Severi" was in cooperation with Tel Aviv University, the Technion–Israel Institute of Technology, the Galilee Research Center for Applied Mathematics, ORT Braude Academic College of Engineering. The conference was held in Tel Aviv and focused on different aspects of Analysis.

Industry-Academy Day

June, 2017

https://www.hit.ac.il/events/IndustrialDay

This event was held at the Holon Institute of Technology. Mathematicians and representatives from industry held a brainstorming day on State Dependent Coefficient Form and Condition and Existence of Non-Symmetric Riccati Equations that arise in different applied fields.
This event was supported by The COST action TD1409 MI-NET.

Conference on Complex and Harmonic Analysis III

June, 2017

http://golberga.faculty.hit.ac.il/CHA17/CHA17.html

The conference was devoted to the memory of Prof. Uri Srebro. It provided a forum for discussion and exchange of new ideas, concepts, and recent developments in broad fields of Modern Analysis, including Complex Analysis, Harmonic Analysis and PDE and Quasiconformal Mappings.

The First Israeli Modelling Week

July, 2017

http://www.braude.ac.il/conferences/modelling_week_israel_2017/

This event took place in Nahariya, Israel, between July 2 and 7, 2017.
During this week, around 40 researchers, engineers, and representatives of industry from Germany, UK, Serbia, Ukraine, Brazil and elsewhere, worked in mathematical modeling and enhanced their collaborative and communication skills in a multinational and multidisciplinary environment. The four industrial projects investigated were: a delivery problem, carp growing, frequency assignment in cellular networks, and design of a printed circuit board.
This event was partially supported by the COST action TD1409 *MI-NET*.

Industry-Academy Day

October, 2017

This event brought together academics from different fields and representatives from industry for a brainstorming event on facing the challenges of modeling a chronic disease and developing a proximity measurement between "similar" patients with the same disease.
This event was supported by the COST action TD1409 MI-NET.

Regional Conference for Teachers in Mathematics in Secondary Education

November, 2017

http://www.braude.ac.il/files/conferences/2017/MathTeachersWorkshop211117.pdf

This event aimed to create a bridge between academia and schools. This year's event focused on mathematical literacy as a lever for meaningful learning.

The Twentieth Israeli Mini-Workshop in Applied and Computational Mathematics

December, 2017

http://www.braude.ac.il/conference/mini-workshop_2017/

The idea of these workshops is to create a forum for researchers, especially young faculty members and students, to get to know other members of the community and to promote discussion and collaboration.

Workshop on Mathematical Education in Science and Technology

in honor of Buma Abramovitz's retirement

February, 2018

http://braude.ac.il/conferences/the_workshop_on_mathematical_education_in_science_and_technology2018/

Perspectives in Modern Analysis

May, 2018

http://golberga.faculty.hit.ac.il/PIMA18/PIMA18.html

This joint event with Holon Institute of Technology (HIT) was held at HIT in honor of distinguished Israeli analysts Dov Aharonov, Samuel Krushkal, Simeon Reich, and Lawrence Zalcman.
The meeting provided a forum for discussions and exchange of new ideas, perspectives and recent developments in the broad field of M**odern Analysis.**

Regional Conference for Teachers of Mathematics in Intermediate Schools

October, 2018

http://www.braude.ac.il/files/conferences/2018/math/MathTeachersWorkshop2018.pdf

This is the second year in a row that this event has taken place. The focus was on "Quality, excellence, and creativity in mathematics.

A joint conference on Lie Groups, Lie Algebras, and Applications

November 2018

http://www.braude.ac.il/conferences/2018/math/

A joint conference on "Lie groups, Lie algebras and applications" organized by ORT Braude College and the University of Haifa was held on November 28-29, 2018.
The first day of the conference, November 28th, took place at ORT Braude College.
The second day, November 29th, took place at the University of Haifa.

Industry-Academia Day

December 2018

http://www.braude.ac.il/conferences/2018/industry-academy_day/

This event brought together 32 academics, mathematicians, industrial engineers, biotechnologists, and industrial practitioners to discuss and study a challenging multi-disciplinary problem presented by the Tnuva company: "In what ways can we maximize protein yield based on historical data and analytical relationships in dairy manufacturing?"
This event was supported by the COST action TD1409 MI-NET.

Workshop on Geometry and its Applications

December 2018

http://www.braude.ac.il/conferences/2018/workshope/

The goal of this workshop was to bring together researchers whose interests cover multifaceted and dynamic aspects as much as possible the multifaceted and dynamic aspects of geometry, both pure and applied.

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A. Gibali
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F. Jacobzon
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Journal of Visual Communication and Image Representation
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Computer Methods and Programs in Biomedicine

V. Turetsky
Journal of Optimization Theory and Applications
Journal of the Franklin Institute
IEEE Transactions on Aerospace and Electronic Systems
Optimization
Dynamic Games and Applications
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International Journal of Control
Journal of Guidance, Control and Dynamics
Pure and Applied Functional Analysis
Aerospace Science and Technology
International Game Theory Review

INVITED TALKS

M. Elin
International Workshop on Conformal Dynamics and Loewner Theory, Senday, Japan, 2018
Professor M. Lanza de Cristoforis' Seminar, University of Padova, Italy, 2018
Professor S. Reich's Seminar on Nonlinear Analysis, Technion–Israel Institute of Technology, Israel, 2018
Third Workshop on Complex and Harmonic Analysis, Holon, Israel, 2017
Computational Methods and Function Theory, Lublin, Poland, 2017
International Conference in Functional Analysis - Banach Conference, Lviv, Ukraine, 2017
Uzbek-Israeli International Conference on Contemporary Problems in Mathematics and Physics, Tashkent, Uzbekistan, 2017
International Conference on Complex Analysis and Related Topics, Lviv, Ukraine, 2016
XVIII-th Conference on Analytic Functions and Related Topics, Chelm, Poland, 2016
INDAM Conference on Geometric Function Theory in Higher Dimension, Cortona, Italy, 2016
Professor S. Reich's Seminar on Nonlinear Analysis, Technion–Israel Institute of Technology, Israel, 2016

V. Glizer

Saddle-Point Equilibrium Sequence in Singular Infinite Horizon Zero-Sum Linear-Quadratic Differential Game with State Delays at the German-Israeli Research Workshop on Optimization, Haifa, Israel, October 16-19, 2017.

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Algebraic Modes of Representations and Nilpotent Orbits, Celebrating Anthony Joseph's 75 birthday, Israel, July 2017.

L. Karp

Complex Functions, Operators, Partial Differential Equations, and Applications in Mathematical Physics, Mittag–Leffler Institute, Stockholm, Sweden, June 12–16, 2017. The Schwarz potential: an overview of various aspects.

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The Geometry of Networks, School of Software Technology, Dalian, China, September 29, 2018.

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Department of Mechanical Engineering

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RESEARCH AREAS

A PRESCRIPTIVE MODEL OF THE CONCEPTUAL ENGINEERING DESIGN PROCESS BASED ON PARAMETER ANALYSIS AND C-K THEORY

Ehud Kroll and **Gil Weisbrod** (Technion–Israel Institute of Technology)

The objective of this research is to propose a new prescriptive model for conceptual engineering design based on a methodology called Parameter Analysis and a relatively new descriptive model called C-K Theory. Parameter Analysis began in the 1970s at MIT as a training methodology for innovators, and has developed over the last 20 years into a prescriptive model with clear and distinct steps. These steps lead the designer through the process of starting with a rough idea and turning it into an elaborate conceptual design of a realizable product. Parameter Analysis, however, lacks in not having a strong theoretical foundation, so it is difficult to establish its "correctness" and its relation to other design methodologies and tools. C-K Theory has gained a reputation for being a very general descriptive model of the design process, encompassing everything from the initial need statement, through generation of new scientific knowledge, to yielding breakthrough designs. It seems especially suitable for capturing highly innovative design processes. C-K Theory, however, lacks in its prescriptive aspect: it can explain the activities during design, but does not guide the designer as to what to do next at any given moment. This research, therefore, studies Parameter Analysis in light of C-K Theory and vice versa, using a multitude of case studies in which both models have been and will be applied. The goal is to generate a new prescriptive model of conceptual engineering design that includes the benefits of both Parameter Analysis and C-K Theory. The object is to obtain a model comprising a clear and concise step-by-step procedure that is conducive to teaching and practicing design,

and at the same time, rooted in a theoretical foundation to support its scientific validity and allow comparison with other design models. The expected significance of this research is the contribution to the theory and practice of engineering design, eventually leading to improved design processes and better designed products.

Keywords: Conceptual design, parameter analysis, C-K theory

ABDUCTION IN DESIGN

Ehud Kroll and **Lauri Koskela** (University of Huddersfield, UK)

The pragmatist philosopher Peirce defined abduction as the only type of inference capable of producing a new idea. Influenced by Peirce's seminal writings and subsequent treatments on abduction in the philosophy of science, over the last 40 years, design scholars have endeavored to shed light on design by means of the concept of abduction. A review and an evaluation of the related literature, however, suggest that research into abduction in design is still undeveloped. This research shows gaps in coverage, lack of depth, and diverging outcomes. The difficulties at hand may be the cause of this situation: diverging developments of the concept of abduction in the philosophy of science, the differences in context between science and design, and the embryonic state of the science of design itself. By focusing on the differences between science and design as well as empirical knowledge of different phenomena comprising design, new conceptions of abduction in design are derived. Given the differences of context, proponents contend that abduction in design can show characteristics not found or still unidentified in science. Design abduction may emerge in any part of the design process. Abduction can occur in connection to practically all inference types in design. It is a property of an inference besides being an inference itself. Abduction usually leads to an idea new to the context. The main criterion of an abducted insight in design is its utility. A number of the most important abductive inference types as they occur in design are studied in more detail, thus covering regressive inferences, composition, transformation, manipulative abduction, decomposition, analogical reasoning, and invention of requirements.

Keywords: Abduction, innovative abduction, design reasoning

MULTI-OBJECTIVE GAMES

Erella Eisenstadt, Gideon Avigad, and Amiram Moshaiov (Tel Aviv University)

This research focuses on the applications of evolutionary and co-evolutionary algorithms for solving multi-objective games under undecided objective preferences.

Keywords: Optimization, evolutionary computation, multi-criteria decision making

DYNAMIC MIMICKING

Avi Weiss and Uri Ben Hanan

Research and development of a robot capable of transporting a wheelchair over obstacles, utilizing the chair's own user interface to drive the robot. Patented.

Keywords: Wheelchair dynamics, robotics, maneuverability

INVERSE GROUND EFFECT ON A DOWNWARD THRUSTING PROPELLER

Avi Weiss and Ayelet Goldstein

While developing a wall-climbing robot utilizing downward thrust propellers for increasing traction, a decrease in thrust was discovered when propellers get close to the ground. Whereas ground effect usually increases lift, in this case we observe the opposite phenomenon, which has not yet been investigated. Initial experimental work shows that increasing the distance of the propellers from the ground increases the thrust.

Keywords: Climbing robot, ground effect

FRICTION STIR WELDING (FSW)

Michael Regev and **Stefano Spigarelli** (Università Politecnica delle Marche, Ancona, Italy)

Because friction stir welding (FSW) is a non-fusion welding process, it has many advantages over conventional welding processes. Among these advantages are the elimination of hot and cold cracking and the ability to join non-weldable alloys. The processes of welding AZ31B to other alloys; e.g. AA6061, as well as welding AA2024, are studied together with the creep properties of the weld.

Keywords: Friction stir welding, aluminum alloys, AA6061, AA2024

FRICTION STIR PROCESSING (FSP)

Michael Regev and **Stefano Spigarelli** (Università Politecnica delle Marche, Ancona, Italy)

Friction Stir Processing (FSP) is a severe plastic deformation process derived from Friction Stir Welding (FSW). The aim of FSP is to obtain a stir zone with very fine grain size. As in FSW, in FSP a non-consumable rotating tool with a shoulder and a pin traverses the parent material and produces intense plastic deformation. The 2024 (Al-4%Cu-1.5%Mg) aluminum alloy is one of the most widely used materials for airplane structures and as such has been investigated in depth to clarify the relationships between its microstructure and its mechanical properties. Unlike the case of FSW of the 2024 aluminum alloy, very few publications have investigated FSP of the 2024 aluminum alloy. The current research deals with the microstructure development of AA22024 during FSP.

Keywords: Friction stir processing, aluminum alloys, AA2024

Mg-BASED AMORPHOUS ALLOYS

Michael Regev and **Alexander Katz-Demyanetz** (Technion–Israel Institute of Technology)

Crystalline magnesium alloys are attractive due to their high strength-to-weight ratio. In addition, amorphous alloys offer high corrosion resistance and good mechanical properties. One drawback of amorphous alloys is the high cooling rates required to achieve an amorphous microstructure. Ongoing research in this area, therefore, focuses on the development of amorphous alloys that can be cast by conventional processes. Special attention is paid to the microstructure characterization by using advanced characterization tools such as High Resolution Transmission Electron Microscopy (HRTEM).

Keywords: Metallic glass, melt spinning, amorphization

MICROSTRUCTURE AND MECHANICAL PROPERTIES OF $Ta_{20}Nb_{20}Hf_{20}Zr_{20}Ti_{20}$ HIGH ENTROPY ALLOY

Michael Regev and **Alexander Katz-Demyanetz** (Technion–Israel Institute of Technology)

Because modern jet engines require larger and larger parameters, improved creep properties are essential for the aerospace industry. The currently used Ni-based superalloys are reaching their limits, and since the beginning of the 21st century new alloys known as High Entropy Alloys (HEAs) have begun to look attractive. HEAs can be regarded as solid solution alloys that contain at least five alloying elements in equal or near equal atomic percentages, and this large number of alloying elements results in maximizing the configurational entropy of the disordered solid solution. However, the microstructure of certain HEAs can include nano-precipitates, ordered solid-solution phases, disordered solid-solution phases, and even amorphous phases. Among the various systems of alloying elements studied, the $Ta_{20}Nb_{20}Hf_{20}Zr_{20}Ti_{20}$ alloy seems to be attractive due to its reduced density of 9.94 g/cm^3.

Keywords: High entropy alloys, $Ta_{20}Nb_{20}Hf_{20}Zr_{20}Ti_{20}$

DRILLING IN ALUMINUM ALLOYS

Michael Regev and **Uri Ben-Hanan**

The inner surface of holes drilled in AA2024 is investigated to find a correlation between the drilling parameters, microstructure changes, force measurements, and acoustic emission.

Keywords: Drilling, aluminum alloys, microstructure, AA2024

AUTOMATIC ADAPTIVE-CALIBRATION OF ACOUSTIC CHAMBER

Avi Weiss and Roee Diamant (Haifa University)

An acoustic chamber needs to isolate sounds produced inside the chamber and reduce sound reflections. The material used to cover the chamber affects these reflection properties. However, different material shapes provide better reflection reduction for different sound frequencies. Thus, for different frequencies, different chambers are used. This research examines a method to actively change the shape of the material, based on the sound frequency produced in the chamber.

Keywords: Acoustic chamber, acoustic reflections, adaptive shape change

MINIATURE AUTONOMOUS JUMPING ROBOT

Uri Ben-Hanan, Avi Weiss, Valentin Zaitsev, Gabor Kosa (Tel Aviv University), and Amir Ayali (Tel Aviv University)

Research and development of a prototype of a tiny robot (~25g) that can jump over a height of 3.5m, glide, and allow control of its direction.

Keywords: Bio-inspired robotics, jumping robot, gliding robot

MINIATURE CLAMPING SYSTEM

Uri Ben Hanan, Avi Weiss, Rafi Wertheim, and Efi Kashani

Manufacturing small parts of only a few millimeters in size may require accuracy in the order of one micrometer. This leads, in turn, to difficulties while taking out the workpiece from the processing machine for measurements or other operations and positioning it back in its exact place afterwards for further processing. In this research project, a three-fingered small chuck is developed. A linear piezo-motor moves the fingers while a force sensor is installed at the end of each one. A special algorithm was developed that enables moving the workpiece in the XY plane while maintaining constant holding forces. Four partners are working on this research project. A-Form AG, a German company producing small injection molds, is the end user of the current research project. Fraunhofer IWU, a research institute, is developing the image processing system for recognizing the position of the workpiece. This system is designed to take a picture of the workpiece prior to removing it from the processing machine and another picture after remounting it, such that any non-desirable displacement of the workpiece will be compensated by the motion system developed by the ORT Braude team. The fourth partner is the Israeli company, H. Azaria PAL Ltd., which specializes in producing high accuracy chucks for processing accurate parts, and is involved in the mechanical design and production of the new smart clamp system. The research project is part of the EUREKA program and is supported by the Israeli Innovation Authority.

Keywords: Small parts manufacturing, accurate positioning and orientation, manufacturing dynamics

COOPERATION OF INVERTED PENDULUM ROBOTS

Uri Ben-Hanan and Avi Weiss

Inverted pendulum robots are highly maneuverable; however, they are very limited when encountering obstacles. We are examining the possibility of getting two (or more) such robots to join together so that they can traverse obstacles. The project deals with the design issues of the robots, communication between the robots to find one another, and the mechanism and algorithm of autonomous connection.

Keywords: Kinematics, dynamics, control, mobile robots, robot cooperation

DEVELOPMENT OF CUTTING FORCE AND CUTTING POWER PREDICTION PROGRAM BY FINITE ELEMENT METHOD (FEM) AND EXPERIMENTAL INVESTIGATION FOR PREDICTING CUTTING ZONE TEMPERATURE IN MICRO END MILLING MACHINING OF METALS

Yitzchak Yifrach and **Mor Elgarisi**

Most of the energy of machining that passes from the cutting tool to the raw material (cutting zone) is transformed into heat. The heat transfer from the cutting zone depends on the thermal properties of the raw material and on its configuration. The temperature rise of the cutting zone may limit the cutting speed and the cutting depth, causing tool wear and limiting its life, and creating thermal stress in the raw material and distortions of its surface quality.

It is therefore highly desirable to predict the cutting zone temperature and relate it to the cutting performance parameters (depth of cut, cutting velocity, feed, linear speed of cutting progress, power required, and specific cutting energy). Due to the nature of metal cutting, it is very difficult and very expensive to measure temperature directly in the cutting zone.

A controlled end milling experiment was compared with a mechanical finite element model (FEM), simulating the actual cutting force distributions and other effects occurring in the cutting zone. Electric milling was controlled by [LabVIEW] software, keeping the torque and rotational speed constant and preventing disruption of fixed air flow. As a reference for the mechanical model, this research conducts end milling experiments with the material Aluminum 6061-T6

To build a reliable mechanical machining model that obviates the need for physical pre-tests, one needs to know, among other things, the cutting power that is transferred from the cutting tool to the raw material. This research shows how to predict the cutting power during machining by finite element analysis (FEA). The cutting power was arrived at indirectly through calculations of the cutting forces that developed during machining (end milling) in the cutting zone at the steady state.

The mechanical model results showed that the actual cutting force is periodic, from which the average machining power in the cutting zone at the steady state is derived. From the actual cutting force, the mechanical power is calculated. This calculation presented a good prediction, with a five percent error of the evolving mechanical power in comparison to experiments performed in the past for those terms.

In addition, for one of the machining models, after providing cutting performance parameters, we can obtain information about the actual cutting force and the cutting power in different cutting parameter conditions without building another machining model.

Keywords: End milling, cutting force, cutting power, finite element method (FEM)

THE EFFECT OF UPPER LIMB LOAD BEARING FEEDBACK SYSTEM ON WALKING STABILITY AND LIMB FUNCTIONING OF POST-STROKE PATIENTS

Orit Braun Benyamin

A stroke is one of the main causes impacting an individual's gait and balance. Hemiparesis is a neurological condition that affects nearly 80% of the 796,000 stroke survivors in the US every year. This lack of sensation, and therefore unreliable biological feedback, can cause a hemiplegic post-stroke patient to not push their walker with symmetric force while relearning to walk. Asymmetrically applied force directly impacts gait and stability, ultimately affecting safety and comfort.

The use of visual biofeedback/forceplate systems for the rehabilitation of patients with hemiplegia has been shown to improve stance symmetry in controlled experiments.

The purpose of this study is to compare outcomes (using the Berg Balance Scale, the Fugl Meyer Test, and the Timed "Up & Go" Test), following balance and mobility retraining by physical therapy, with and without the Handle Grip of a Walker feedback system.

This research is conducted with the physical and occupational therapy units at the Galilee Medical Center in Nahariya.

Keywords: Balance, functional mobility, hemiplegia, stroke, visual and auditory biofeedback

MOTOR FUNCTION IN ADHD

Orit Braun Benyamin

Attention deficit and hyperactivity disorder (ADHD) is a common syndrome affecting 3-20% of children and has become a significant public health problem. These studies aim to investigate posture stability by measuring center of pressure movements and their relation to dual tasks and cognitive load. The initial results show that students with ADHD have larger center of pressure movements compared with non-ADHD students. There is a striking elevation in the sway area of ADHD subjects when undergoing dual tasks and cognitive load.

Keywords: Attention deficit hyperactivity disorder, postural stability, single task, dual task

UPPER HAND TREMOR DURING A WRITING TASK – DEVELOPMENT OF A MEASUREMENT SYSTEM

Navit Roth and **Orit Braun Benyamin**

A major motor limitation that exists in humans is the phenomenon of tremor. Tremor may be the outcome of chronic or neurological diseases and pharmacological toxicological background. Tremor occurs mostly in the upper limbs, and the intensity (amplitude) and frequency level of tremor can vary throughout the day and may depend on stress level, amount of physiological effort of the relevant muscles, medication, movement characteristics, and orientation of the limb. Tremor assessment and diagnosis is carried out by the doctor through general neurological and general examination and does not involve quantified measurement systems. Development of an accurate, reliable measuring system, with a self-test capability, will enable doctors and people suffering from tremor to evaluate the effect and efficiency of treatment on tremor characteristics by means of quantitative parameters.

This research aims to define and build a tremor measuring system while performing a writing task. The system will include and compare measurements from accelerometers, motion capture analysis of relevant points through digital video analysis and coordinates of the pen pointer, and pen tilt and pen pressure measurements from a tablet system.

Keywords: Tremor, motion measurement, biomechanics

DEVELOPING DEVICES FOR PEOPLE WITH DISABILITIES: CHALLENGES AND GAINS OF PROJECT-BASED SERVICE LEARNING

Orna Muller, Vered Dangur, and Orit Braun Benyamin

Project-Based Service Learning (PBSL) is a hands-on pedagogical approach that involves the development of a product for the benefit of society. PBSL provides students with opportunities to design and develop innovative solutions for real clients with real needs. The study focuses on the perceptions of 13 mechanical engineering graduates who participated in a single-semester Rehabilitation Biomechanics course that includes development of tailor-made and low-cost assistive devices for people with special needs. The study aims to evaluate the long-term impact of PBSL on graduates after several years of employment in industry. The course is a part of an ORT Braude College of Engineering flagship project: "Engineers on Behalf of People with Disabilities".

Keywords: Project-based service learning, engineering education, people with disabilities, rehabilitation biomechanics

MULTI-OBJECTIVE NEURO-EVOLUTION

Adham Salih and Amiram Moshaiov (Tel Aviv University)

In recent years there has been an increase of interest in designing Neuro-Controllers (NCs) using multi-objective evolutionary computation techniques. Given the vast variety of multi-objective

evolutionary algorithms, selecting one for a specific problem is a non-trivial task. This research aims to provide a comprehensive comparison between two well-known evolutionary algorithms including NSGA-II and MO-CMA-ES, as applied to the evolution of NCs. The numerical investigation is based on two multi-objective navigation problems, in conjunction with two types of networks. In all the cases studied it was found that MO-CMA-ES is better than NSGA-II. The reason for the superiority is explored. First, it is shown that the competing convention problem cannot serve as an explanation of the observed phenomenon. A unique method is suggested for investigating the convergence of the networks. Based on the proposed methodology, it is found that for the cases studied, MO-CMA-ES has much better convergence properties. The differences between the two algorithms, and the uniqueness of the considered neuro-evolution problems, lead to the following hypothesis: It is postulated that MO-CMA-ES is superior as a result of its ability to fine-tune the solutions by changing particular genes, one at a time.

Keywords: Evolutionary neural-network, neuro-evolution, evolutionary robotics, multi-objective optimization

MANY-OBJECTIVE TOPOLOGY AND WEIGHT EVOLUTION OF ANNs

Adham Salih and Amiram Moshaiov (Tel Aviv University)

Neuro-Evolution (NE) combines the adaptation power of Artificial Neural Networks (ANNs) with the advantages of evolutionary computation to find networks capable of solving different tasks. The potential of NE has been successfully demonstrated in many studies involving application areas such as robotics, artificial life, computer games, and agent technologies. A major advantage of the evolutionary approach to ANNs is its ability to simultaneously search for both the optimal topology and weights. This type of NE is known as TWEANN (Topology and Weight Evolution of Artificial Neural Networks). This research aims at the development of efficient and reliable MO-TWEANN algorithms, as well as testing and comparing them in the context of robot navigation by way of neuro-controllers (NCs). The envisioned NCs for autonomous robots should cope with generalization and adaptation to changing environments. Specifically, in contrast to most of the existing MO-TWEANN algorithms that are restricted to a few objectives, we aim at algorithms that may handle a large number of objectives. This is expected to support the simultaneous evolution of NCs to many different environments, hence accelerating the evolution of generalized solutions.

Keywords: Evolutionary neural-network, neuro-evolution, evolutionary robotics, many objective optimization, TWEANN

MANY-OBJECTIVE TWEANN FOR SOLVING MULTI-CLASS CLASSIFICATION PROBLEM

Adham Salih and Amiram Moshaiov (Tel Aviv University)

This research deals with using many-objective topology and weight evolutionary artificial neural networks (TWEANN) algorithms for solving multi-class classification problems. The many-

objective (more than three objectives) feature opens up new possibilities for designing mixtures of class-experts (ensembles) for classifying many classes. In particular, the problem is defined as a many-objective problem in which each objective is associated with one class.

Keywords: Evolutionary neural-network, neuro-evolution, Pareto, many-objective optimization, multi-class, ensemble

TWO-PHASE FLOW; CREEPING FLOW ON SURFACES; ACCELERATED CHARGES; MANIFOLDS; FRICTION ANALYSIS

Ayelet Goldstein and **Ofer Eyal**

1. Multi-phase developed flow in a pipe: use of Green functions and other mathematical techniques for better understanding and simpler solutions for the physical situation; analogy with electric fields, currents, and potentials is investigated for modelling. Point singularities and their physical explanation, together with practical implications, are investigated.
2. Creeping flow on surfaces: use of complex analysis for finding pressure and velocity field when the flow is constrained to surfaces, with various topologies. Point sources and vorticity centers are studied as a cause for pressure gradients and velocity field.
3. Accelerated charges radiation: a new approach for the radiation emitted by relativistic accelerated charges.
4. Some of nature's laws are modified when space is regarded as a non-flat manifold: investigating the fundamental solution for essential operators. Application for multidimensional electrodynamics.
5. Friction: a) the puzzle of the modes of passage of a body from rest to movement; b) the motion of a body in the presence of friction, propelled by a rotating mass; and c) assisting the movement under friction by an internal movement.

Keywords: Two-phase laminar separated flow, potential problems on manifolds, accelerated relativistic charges, spheres, friction

ACTIVE ROBUST OPTIMIZATION

Shaul Salomon, Gideon Avigad (Vineland Research and Innovation Center, Canada)**, Robin Purshouse,** and **Peter Fleming** (University of Sheffield, UK)

This study presents a new framework for evaluation, comparison, and optimization of changeable products. Any product that can change its configuration during normal operation can be considered as a changeable product, making the framework widely applicable. By applying the methodology, designers can cope with uncertainties through adaptability rather than creating over-conservative designs. The framework is constructed around a new class of optimization problems – the *Active Robust Optimization Problem*. It is a nested optimization problem: the inner problem searches for the optimal configuration of a given candidate design at different scenarios of the uncertainties.

According to the distribution in performance with the optimal configurations, the outer problem searches for the robust set of features of the changeable product itself.

Keywords: Optimization, design for uncertainties, multi-criteria decision making, adaptive design

OPTIMIZATION OF A MULTI-ARM ROBOTIC FRUIT HARVESTER

Shaul Salomon, Gideon Avigad (Vineland Research and Innovation Center, Canada), and **Avi Kahani** (FFRobotics)

This study is part of the design process of a multi-arm robotic fruit harvester. FFRobotics is a start-up company that has developed a patented robotic arm for picking apples and other fruits. To use the technology on a commercial scale, a multi-arm robotic harvester that operates 12 arms simultaneously is being developed. The optimization study includes algorithms for coordination between the arms to minimize interference and maximize yield, and finding the optimal design parameters of the harvester itself, such as number of arms, dimensions, and component selection.

Keywords: Optimization, design for uncertainties, robotics, smart agriculture

LOCOMOTION OF A SKATING ROBOT

Shaul Salomon and Avi Weiss

Skating is a unique form of locomotion that enables fast and energy efficient movement on slippery surfaces such as ice. High efficiency can also be achieved on non-slippery flat surfaces using roller skates. This research studies the kinematics and dynamics of the skating motion to design an autonomous robot that can efficiently progress on ice and other flat surfaces.

Keywords: Kinematics, dynamics, control, mobile robots

SOOT VOLUME FRACTION MEASUREMENT USING A DIGITAL CAMERA

Victor Chernov

Soot is a particulate combustion product consisting of aggregates of small carbon spheres. The spheres are usually tens of nanometers in diameter. The aggregate size can vary between a few and several dozen spheres. In most cases, the volume fractions are of an order of magnitude from a single to tens of ppm. Soot is an unwanted product of many combustion systems and poses a major threat to health and the environment. However, it is not an inherent product of combustion, and it is possible to have combustion without it.

One of the challenges in soot research is fast, reliable measurement of soot volume fractions. Low volume fractions and hostile environments make the task non-trivial. The measurement process is long, sensitive to various parameters, and cumbersome. This research develops an experimental system for soot volume fraction and temperature measurement in laminar flames. The system

is based on the Spectral Soot Emission (SSE) measurement system for laminar diffusion flames. It is assumed that in a sooting flame, the radiance in the visible range can be attributed to soot. By measuring it at different wavelengths, temperature and soot volume fractions can be found. This research attempts to improve the system using high-resolution, high-speed cameras, and advanced image processing techniques to characterize diffusion flames. These improvements can reduce the sampling time of a single flame from one day's work to less than an hour. A larger number of points can be sampled for each flame, enabling better flame analysis.

Keywords: Diffusion flame, soot, combustion

ELECTROMECHANICAL BUCKLING AND NUMERICAL MODELING OF MULTI-PHYSICS PHENOMENON

Samy Abu-Salih

Modeling of micro electromechanical systems (MEMS) is a pivotal step in achieving maximum efficient design and high accuracy of micro systems (MEMS devices). The research focuses on:

- Electromechanical buckling of micro structures with application to MEMS devices
- Modeling the chemo-electro-mechanical response of micro hydrogel structures
- Modeling the electromechanical response of micro piezoelectric sensors and actuators
- Modeling the mechanics of cavitation

Keywords: Modeling of micro systems, MEMS, electromechanical buckling (EMB), cavity expansion in solids

MODELING OF CHEMICAL NITRIFICATION PROCESSES IN ANAMOX

Samy Abu-Salih, Essam Sabah, Carlos G. Dosoretz (Faculty of Civil and Environmental Engineering, Technion–Israel Institute of Technology**), and Ali Nejidat (Institute for Desert Research, Ben-Gurion University)**

- Modeling of chemical nitrification processes in ANAMOX bacteria

Keywords: Nitrification process

DEVELOPING CONSTITUTIVE MODEL FOR PLASTIC MATERIALS WITH APPLICATION TO METAL CUTTING PROCESSES

Samy Abu-Salih and Rami Masri

The focus:

- Developing a new explicit constitutive model for plastic material response
- Finite Element Analysis (FEA) of metal cutting and chip generation
- Finite element modeling of cavity expansion in solids

Keywords: Metal cutting, chip generation, finite element analysis, constitutive model of plastic materials

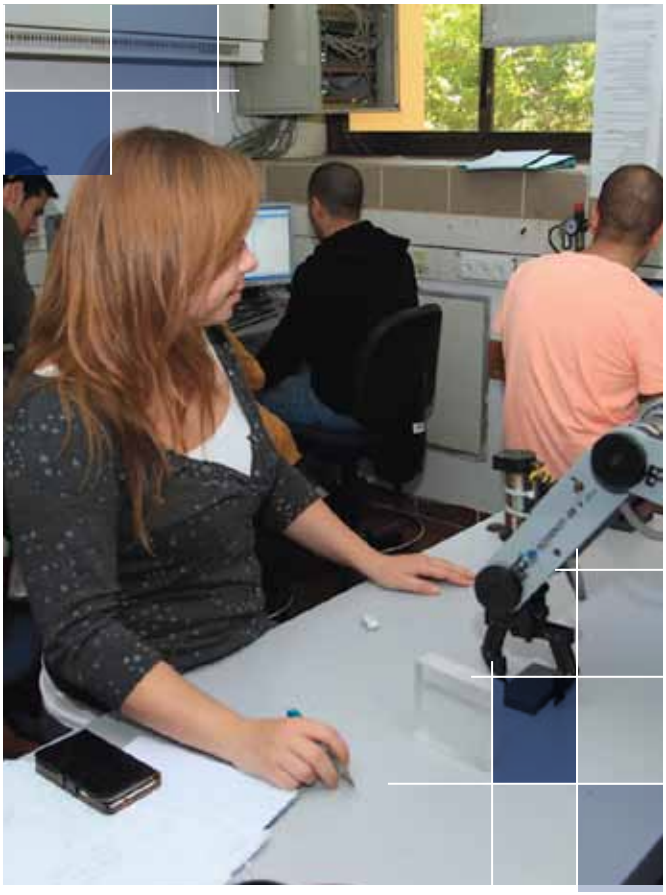
MECHANICS OF CAVITATION, PENETRATION, PERFORATION, AND SHIELDING

Rami Masri

The research focus:

- Investigating the mechanics of deep penetration and ductile plate perforation of protective targets by rigid projectiles
- Investigating the mechanics of hole growth (cavity expansion) in protective plates under different conditions
- Investigating the mechanics of quasi-static and dynamic cavitation phenomena in different solids
- Investigating the mechanics of hole growth in hyperelastic materials (biological tissues)

Keywords: Cavity expansion, cavitation in solids, ductile hole growth, deep penetration, plate perforation, ballistic limit, specific cavitation energy, biological tissues



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J. A. Duro, R. C. Purshouse, S. Salomon, D. C. Oara, V. Kadirkamanathan, and **P. J. Fleming**, sParEGO – A hybrid optimization algorithm for expensive uncertain multi-objective optimization problems. *10th International Conference on Evolutionary Multi-Criterion Optimization (EMO 2019)*, East Lansing, MI, USA, 2019.

L. Koskela and **E. Kroll,** Model-based abduction in design. *8th International Conference on Design Computing and Cognition (DCC'18)*, Lecco, Italy, July 2-4, 2018.

N. R. Aghamohammadi, S. Salomon, Y. Yan, and **R. C. Purshouse**, On the effect of scalarising norm choice in a ParEGO implementation. *9th International Conference on Evolutionary Multi-Criterion Optimization*, Munster, Germany (EMO 2017), 2017.

U. Ben Hanan, A. Weiss, and **V. Zaitsev,** Jumping efficiency of small creatures and its applicability in robotics. *15th Global Conference on Sustainable Manufacturing*, Haifa, Israel, Sep. 2017.

M. Harel, E. Matalon-Eisenstadt, and **A. Moshaiov**, Solving multi-objective games using a-priori auxiliary criteria. *In Evolutionary Computation (CEC),* 2017 IEEE Congress on (pp. 1428–1435), San Sabastian, Spain, 2017.

E. Kroll, and **L. Koskela,** Studying design abduction in the context of novelty. *Proceedings of the 21st International Conference on Engineering Design (ICED17)*, Vol. 7: Design Theory and Research Methodology, Vancouver, Canada, August 21-25, 2017.

M. Regev and **S. Spigarelli**, Deformation mechanisms operating during creep of friction stir welded AZ31B magnesium alloy. *Proceedings of IIW 2017 International Conference*, Shanghai, P.R. China, 29-30 June, 2017.

A. Weiss, E. Fadida, and **U. Ben Hanan,** Optimizing step climbing by two connected wheeled inverted pendulum robots. *15th Global Conference on Sustainable Manufacturing*, Haifa, Israel, Sep. 2017.

E. Eisenstadt, A. Moshaiov, and **G. Avigad**, The competing travelling salespersons problem under multi-criteria. *In Proceedings of the 14th Int. Conf. on Parallel Problem Solving from Nature*, PPSN 2016 (pp. 463–472), Edinburgh, Scotland 2016.

I. Gotman, **S. G. Psakhie, A. S. Lozhkomoev,** and **E. Y. Gutmanas,** Iron oxide and gold nanoparticles in cancer therapy. *Proceedings of the International Conference on Physics of Cancer: Interdisciplinary Problems and Clinical Applications*, Tomsk, Russia, 2016.

A. Salih and **A. Moshaiov**, Multi-objective neuro-evolution: Should the main reproduction mechanism be crossover or mutation?, *2016 IEEE International Conference on Systems, Man, and Cybernetics (SMC2016),* Budapest, Hungary, 2016.

S. Salomon, R. C. Purshouse, I. Giagkiozis, and **P. J. Fleming.** A toolkit for generating scalable stochastic multiobjective test problems. *In Proceedings of the 2016 Annual Conference on Genetic and Evolutionary Computation (GECCO 2016)*, pages 597-604, Denver, CO, USA, 2016.

ORAL PRESENTATIONS AT INTERNATIONAL CONFERENCES

L. Koskela and **E. Kroll,** Model-based abduction in design. *8th International Conference on Design Computing and Cognition (DCC'18)*, Lecco, Italy, July 2-4, 2018.

S. Salomon and **R. C. Purshouse**, Toolkit for benchmarking multiobjective robust optimization algorithms. *29th European Conference on Operational Research (EURO 2018)*, Valencia, Spain, 8-11 July, 2018.

V. Zaitsev, U. Ben Hanan, and **A. Weiss**, Miniature jumping robot with consecutive jumping ability. *The 5th International conference on Multibody System Dynamics*, Lisbon, Portugal, June 2018.

E. Kroll and **L. Koskela,** Studying design abduction in the context of novelty. *The 21st International Conference on Engineering Design (ICED17)*, Vancouver, Canada, August 21-25, 2017.

M. Regev and **S. Spigarelli**, Microstructure stability during creep of friction stir welded AZ31B-H24 magnesium alloy and AA2024-T3 aluminum alloy. *IIW 2017 International Conference*, Shanghai, P.R. China, 29-30 June, 2017.

A. Weiss and **U. Ben Hanan**, Cooperation of two two-wheeled inverted pendulum robots. *The 4th International conference on Multibody System Dynamics, Montreal*, QC, Canada, May 2016.

A. Weiss and **U. Ben Hanan**, Two-wheeled AGV cooperating to climb stairs. *The 34th Israeli conference on Mechanical Engineering*, Faculty of Mechanical Engineering, Technion–Israel Institute of Technology, Haifa, Israel, 21-22 November, 2016.

A. Weiss and **U. Ben Hanan,** Performance of a quasi-holonomic mobile robotic carrier in the dynamics mimicking platform. *ECCOMAS Multibody Dynamics*, Prague, Czech Republic, July 2017.

A. Weiss, U. Ben Hanan, and **G. Avigad,** Design of a dynamic mimicking system for enhancing wheelchair traversability. *The 34th Israeli Conference of Mechanical Engineering*, Faculty of Mechanical Engineering, Technion–Israel Institute of Technology, Haifa, Israel, 21-22 November, 2016.

O. Braun Benyamin, A. Toledano-Shubi, and **D. Livne**, ORT Braude College & Western Galilee Medical Center, Collaboration for development of tailor-made rehabilitation equipment in the northern region of Israel, *Rehab Science & Technology Update 2016 Congress*, Airport City, Israel 2016.

A. Salih and **A. Moshaiov**, Multi-objective neuro-evolution: Should the main reproduction mechanism be crossover or mutation?, *2016 IEEE International Conference on Systems, Man, and Cybernetics (SMC2016),* Budapest, Hungary, 2016.

NON-REFEREED CONFERENCE PROCEEDINGS AND ABSTRACTS

A. Goldstein and **O. Eyal,** An analytical solution for creeping flow in a narrow gap between two surfaces related by injected flux. *ICME 2018,* Ben-Gurion University, Israel, 2018.

A. Goldstein and **O. Eyal,** Green's function method for solving the separated two-phase flow in inclined tubes by superposition. *ICME 2018,* Ben-Gurion University, Israel, 2018.

A. Goldstein, A. Ullmann, and **N. Brauner**, Adding a lubricating phase for conveying of a viscous liquid in inclined CAFs. The 6th *International Conference on Energy Challenges and Mechanics ECM6,* Inverness, Scotland, UK, August 14-18, 2016.

A. Goldstein, A. Ullmann, and **N. Brauner**, Exact solutions of core-annular laminar inclined flows. Proc. of the 34th *Israeli Conference on Mechanical Engineering ICME2016,* Technion–Israel Institute of Technology, Israel, November 22-23, 2016.

A. Goldstein, A. Ullmann, and **N. Brauner**, Benefits of adding a lubricating phase for transportation of a viscous fluid in inclined CAFs. *Proc. of the* 34th *Israeli Conference on Mechanical Engineering ICME2016,* Technion–Israel Institute of Technology, Israel, November 22-23, 2016.

R. Masri, Cavitation in solids and ballistic limit predictions for perforation of metal targets by nose-pointed projectile. 34th *Israeli Conference on Mechanical Engineering ICME2016,* Technion–Israel Institute of Technology, Israel, November 22-23, 2016.

GRANTS

O. Braun Benyamin (PI), "MEHALEV": Students of engineering on behalf of people with disabilities, 2018, Zimmer Family Foundation, $25,000.

O. Braun Benyamin (PI), Participation of students and academia in community oriented projects (Rehabilitation Biomechanics), 2017, Council for Higher Education, 40,000 NIS.

O. Braun Benyamin, Participation of students and academia in community oriented projects (Implant Biomechanics), 2017, Council for Higher Education, 40,000 NIS.

O. Braun Benyamin, Flagship project: Rehabilitation knowledge center at ORT Braude College, 2017, Council for Higher Education, 25,0000 NIS**.**

O. Braun Benyamin, "MEHALEV": Students of engineering on behalf of people with disabilities, 2017, Zimmer Family Foundation, $25,000.

O. Braun Benyamin, Multidisciplinary engineering R&D center developing innovative rehabilitative equipment for individuals as well as animals with disabilities, 2017, Rothberg Foundation, $45,000.

M. Regev and **A. Erlikh**, Development of a new thermo-mechanical process for medium carbon steels, Ministry of Economy and Industry, 2017.

E. Kroll, A prescriptive model of the conceptual engineering design process based on parameter analysis and C-K theory, Israel Science Foundation, 1 October, 2012-30 September, 2016, app. $100,000.

O. Braun Benyamin (PI), Participation of students and academia in community oriented projects (Rehabilitation Biomechanics), 2016, Council for Higher Education, 40,000 NIS.

O. Braun Benyamin (PI), Participation of students and academia in community oriented projects (Advanced Engineering Design), 2016, Council for Higher Education, 40,000 NIS.

O. Braun Benyamin, Flagship project: Rehabilitation Knowledge Center at ORT Braude College, 2016, Council for Higher Education, 250,000 NIS.

JOURNAL REFEREES

E. Kroll
Artificial Intelligence for Engineering Design, Analysis and Manufacturing (AIEDAM)
Journal of Engineering Design
Resources, Conservation & Recycling
Research in Engineering Design
Rapid Prototyping Journal

M. Regev
Guest Editor:
Materials
Metals
Reviewer:
Journal of Materials Science
Physica Status Solidi
Materials Science and Engineering B
Journal of Materials Engineering and Performance
Materials and Design
Micromachines
Journal of Non-Crystalline Solids
Coatings
Wear
Journal of Alloys and Compounds
Materials
Metals

A. Weiss
Robotica
Assistive Technology

I. Gotman
Journal of Materials Science: Materials in Medicine
Acta Biomaterialia

S. Salomon

IEEE Transactions on Evolutionary Computation,
Research in Engineering Design

V. Chernov
Combustion and Flame
Propellants, Explosives, Pyrotechnics

R. Masri
International Journal of Impact Engineering
Materials and Design
Journal of Applied Mechanics
International Journal of Protective Structures

INVITED TALKS

M. Regev, M. El Mehtedi, and **S. Spigarelli**, Microstructural changes during creep process of friction stir welded AZ31B-H24. An invited talk at *THERMEC 2016 Conference*, Graz, Austria, 29 May - 3 June, 2016.

M. Regev, S. Spigarelli, and **M. Cabibbo**, Microstructural stability during creep of friction stir welded AA2024-T351 Alloys. A keynote lecture at *EUROMAT 2017 Conference*, Thessaloniki, Greece, 17-21 September, 2017.

M. Regev and **S. Spigarelli**, Microstructural stability during creep of friction stir welded AA2024-T3 Alloy. An invited talk at *THERMEC 2018 Conference*, Paris, France, 8-13 June, 2018.

E. Kroll, Applying the case-study research methodology in engineering design. An invited presentation at *The 9th International Workshop of the Design Theory Special Interest Group of the Design Society*, Mines ParisTech, Paris, February 2, 2016.

E. Kroll, From teaching a design methodology to teaching a design method: The role of design theory. An invited presentation at *The 10th International Workshop of the Design Theory Special Interest Group of the Design Society*, Mines ParisTech, Paris, January 31-February 1, 2017.

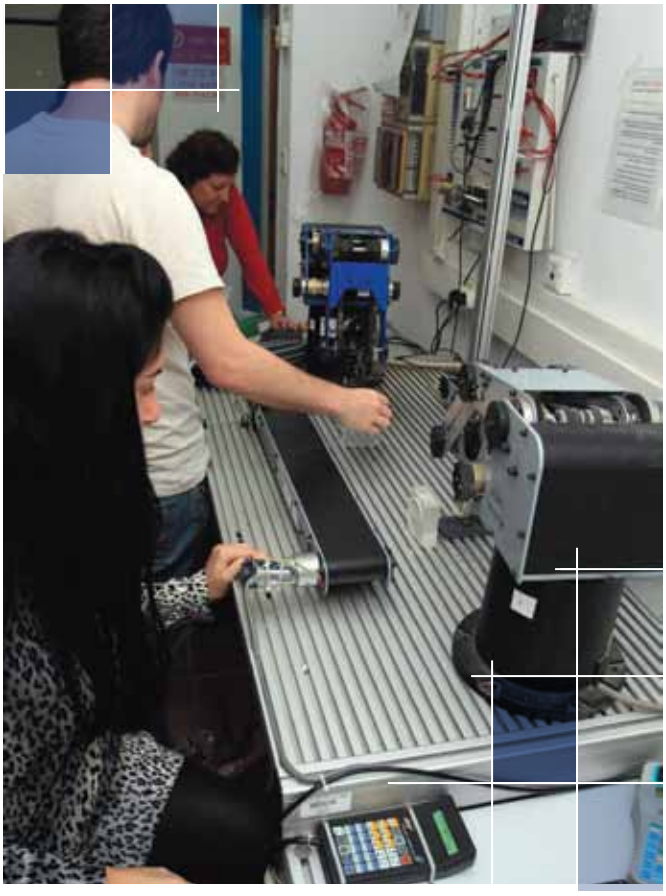
E. Kroll and **L. Koskela**, Varieties of abduction in design. An invited presentation at *The 10th International Workshop of the Design Theory Special Interest Group of the Design Society*, Mines ParisTech, Paris, January 31-February 1, 2017.

E. Kroll and **L. Koskela**, Model-based abduction in design. An invited presentation at *The 11th International Workshop of the Design Theory Special Interest Group of the Design Society*, Mines ParisTech, Paris, January 29-30, 2018.

E. Kroll, Enhancing the parameter analysis method with design theory. An invited presentation at *The 2nd Tutorial on Design Theory*, Mines ParisTech, Paris, January 31-February 2, 2018.

PATENTS

U. Ben Hanan, A. Weiss, and **V. Zaytsev**, Jumping robot, provisional, 62/555,091, Sep. 2017.
R. Diamant and **A. Weiss**, Adaptive acoustic chamber and method for acoustic calibration, provisional, 62/740,403, Oct. 2018.



Department of Physics & Optical Engineering

Dr. Shimshon Kallush
Head of Department

RESEARCH AREAS

HIGH ENERGY ASTROPHYSICS

Dafne Guetta

The research studies the physics and redshift distribution of Gamma-Ray Bursts (GRBs), bursts of 0.1-1 MeV photons lasting for a few seconds. These are very energetic sources that can be used to probe the star formation rate. We study the high energy neutrino and gravitational wave emission from GRBs and other astrophysical sources such as microquasars. We are interested in understanding what are the sources of ultra-high energy cosmic rays and if hadrons are present in the jet of these sources.

Keywords: Neutrino particle, gamma rays

1. M. Della Valle, and **D. Guetta,** GW170817, Implications for the local kilonova rate and for surveys from ground-based facilities. *MNRAS*, 481, 2018, 4355.
2. J. Granot, **D. Guetta**, and R. Gill, Off-axis emission of short GRB jets from double neutron star mergers and GRB 170817A. *MNRAS*, 481, 2017, 1597.
3. J. Granot, **D. Guetta**, and R. Gill, Lessons from the short GRB 170817A: The first gravitational-wave detection of a binary neutron star merger. *ApJ*, 850, 2017, 24.
4. A. Lamastra, F. Fiore, and **D. Guetta,** Extragalactic gamma-ray background from AGN winds and star-forming galaxies in cosmological galaxy-formation models. *A&A*, 607, 2017, 12.
5. I. Di Palma, **D. Guetta**, and E. Amato, Revised predictions of neutrino fluxes from pulsar wind nebulae. *ApJ*, 836, 2017, 159.

6. ARA collaboration and **D. Guetta,** Constraints on the ultra-high-energy neutrino flux from gamma-ray bursts from a prototype station of the Askaryan radio array. *Astroparticle Physics*, 88, 2017, 7-16.
7. C. Righi, F. Tavecchio, and **D. Guetta**, High-energy emitting BL Lacs and high-energy neutrinos - Prospects for the direct association with IceCube and KM3NeT. *A&A*, 598, 2017, 8.
8. A. Lamastra, F. Fiore, and **D. Guetta**, Galactic outflow driven by the active nucleus and the origin of the gamma-ray emission in NGC 1068. *A&A*, 596, 2016, 11.
9. **D. Guetta**, 2016, Neutrinos from gamma ray bursts in the IceCube and ARA. *EPJ Web of Conferences*, 121, id.05001.
10. N. Wygoda, **D. Guetta**, M. A. Mandich, and E. Waxman, The energy budget of GRBs based on a large sample of prompt and afterglow observations. *ApJ*, 824, 2016, 9.
11. L. Yacobi, **D. Guetta**, and E. Behar, Implication of the non-detection of GZK neutrinos. *ApJ*, 823, 2016, 5.
12. K. Murase, **D. Guetta,** and M. Ahlers, Hidden cosmic-ray accelerators as an origin of TeV-PeV cosmic neutrinos. *Physical Review Letters*, *116*(7), 2016.
13. G. Nir, **D. Guetta, H.** Landsman, and E. Behar, Ultra high energy neutrinos from gamma-ray burst afterglows using the Swift-UVOT data. *ApJ*, 817, 2016, 142.

INVITED TALKS AT CONFERENCES

1. **December 2017, Invited plenary talk,** International High Energy Physics Conference, Playa Del Carmen, Mexico
2. **November 2016, Invited talk** at Italian Conference on GRBs, Bergamo, Italy
3. **October 2016, Invited talk** at the Astrophysics Department of Columbia University, New York, USA
4. **June 2016, Invited talk** at RICAP2016, Frascati, Italy
5. **February 2016, Invited plenary talk** at the Antares-KM3NET meeting, Germany

HIGH TEMPERATURE SUPERCONDUCTIVITY (EXPERIMENTAL)

Menachem Shay

The main goal of the research is to examine the hypothesis that there is a linear relation between the maximal transition temperature to the superconducting state and the magnetic coupling between neighboring unit cells in high temperature superconductors. The tool we use to probe the magnetic coupling is two-magnon Raman scattering. In addition, the phase diagram of the samples is studied by means of muon spin rotation, transport and magnetization measurements. The samples are high quality single crystals, grown using an optical image zone furnace at the Technion. In addition, samples in the form of thin film are prepared and their properties are examined and compared to their matching crystals. This allows for precise determination of the sample conductivity above Tc, which may shed light on the pairing mechanism of high-temperature-superconductors.

Keywords: HTSC, Raman scattering, isotope effect

QUANTUM CONTROL

Shimshon Kallush

Quantum Control (QC) is dedicated to driving objectives into a given goal in the microscopic world, which is governed by quantum mechanics. Our research interests within this area range from fundamental research to theoretically and experimentally applicative aspects. We deal with basic questions of the applicability of QC, such as the sensitivity of a given control solution on the various parameters of the system. In our applicative research we explore numerical methods for computing numerically exact quantum dynamics under general conditions to serve as a tool for understanding and predicting the ability to control quantum systems. We also collaborate closely with the experimental group of Prof. Phillip Gould at the University of Connecticut in seeking ways to apply quantum control methods to create ultra-cold (micro Kelvin) molecules with the aid of light pulses that fit the typical dynamics of these species i.e. in nanosecond time scales. Recently we have started to collaborate with Dr. Sharly Fleischer from Tel Aviv University on the control aspects of molecular alignment and orientation.

Keywords: Quantum mechanics, control, ultracold physics, numerical propagation of dynamical systems, molecular alignment and orientation

1. A. Aroch, **S. Kallush**, and R. Kosloff, Optimizing the multicycle rotational cooling of diatomic molecules. *Physical Review A*, 97, 053405, 2018.
2. **S. Kallush**, J. L. Carini, P. L. Gould, and R. Kosloff, Directional quantum-controlled chemistry: Generating aligned ultracold molecules via photoassociation. *Physical Review A*, 96**,** 053613, 2017.
3. D. Rosenberg, R. Damari, **S. Kallush**, and S. Fleischer, Rotational echoes: Rephasing of centrifugal distortion in laser-induced molecular alignment. *Journal of Physical Chemistry Letters*, 8, 2017, 5128.
4. J. L. Carini, **S. Kallush**, R. Kosloff, and P. L. Gould, *Efficient formation of ultracold molecules with chirped nanosecond pulses*. *Journal of Physical Chemistry A,* 2016, DOI**:** 10.1021/acs.jpca.5b10088.
5. R. Damari, **S. Kallush**, and S. Fleischer, Rotational control of asymmetric molecules: dipole- vs. polarizability- driven rotational dynamics. *Physical Review Letters,* 117, 2016, 103001.
6. **S. Kallush,** A. Aroch, and R. Kosloff, Quantifying the induction of coherence into thermal quantum systems**,** (submitted to *PRA*).

SUPERCONDUCTIVITY (THEORETICAL)

Jorge Berger

This research focuses on geometric effects in mesoscopic superconducting samples—mainly rings—by means of the Ginzburg-Landau model and its generalizations. Special attention is devoted to thermal fluctuations, which are studied by means of appropriate Langevin functions.

Keywords: Superconducting rings, Ginzburg-Landau, Kramer Watts-Tobin, Langevin

1. **J. Berger**, The stationary SQUID. *Journal of Low Temperature Physics*, 191, 2018, 330-343.
2. **J. Berger**, Flux-induced Nernst effect in low-dimensional superconductors. *Physica C,* 533, 2017, 105–108.
3. **J. Berger**, Stationary nano-SQUID: theoretical investigation and feasibility analysis. *Journal of Physics: Condensed Matter*, 29, 2017, 29LT01.
4. O. J. Sharon, A. Sharoni, **J. Berger**, A. Shaulov, and Y. Yeshurun, Current-induced SQUID behavior of superconducting Nb nano-rings. *Scientific Reports*, 6, 2016, 28320.

NANOPHOTONICS AND LIGHT-MATTER STRONG COUPLING

Atef Shalabney

When electromagnetic radiation is confined into tiny regions, the nature of the interaction of radiation with matter becomes of great interest from both the fundamental point of view as well as for many optical engineering applications. This radiation confinement, usually accompanied by an extraordinary enhancement of the electric field intensity, accounts for many interesting effects such as surface enhanced Raman scattering (SERS), enhanced optical transmission, enhanced absorption, and emission of light, and enables high-resolution microscopy and imaging. However, these effects are the outcomes of a weak light-matter interaction where the properties of the material do not change.

In the strong coupling regime, on the other hand, a resonant optical field can also couple to the transition dipole moment of a material oscillating with a given frequency and give rise to two new hybrid-light-matter states that are separated by the vacuum Rabi frequency. This regime is typically achieved by placing the material in the confined electromagnetic field of an optical cavity or a surface plasmon mode that is resonant with a given material transition.

In this research, we study the interaction nature of light into confined regions with matter. In the weak coupling regime, we exploit the enhanced electromagnetic field to boost optical phenomena for bio sensing, disease diagnoses, and molecular detection. In the strong coupling regime, we investigate the modification in the materials properties due to the formation of the new hybrid states.

Keywords: Light-matter strong interaction, Surface Plasmon Polaritons, Bio Sensing, Molecular Detection, Enhanced Spectroscopy, Enhanced Raman Scattering

PAPERS IN REFEREED JOURNALS

T. Chervy, A. Thomas, E. Akiki, R. Vergauwe, **A. Shalabney,** J. George, E. Devaux, J. A. Hutchison, C. Genet, and T. W. Ebbesen, Vibro-polaritonic IR emission in the strong coupling regime. *ACS Photonics*, 2017, DOI: 10.102/acsphotonics.7b00677.

J. George, T. Chervy, **A. Shalabney,** E. Devaux, H. Hiura, C. Genet, and T. W. Ebbesen, Multiple Rabi splitting under ultra-strong vibrational coupling. *Phys. Rev. Lett*., 117, 2016, 153601.

A. Thomas, J. George, **A. Shalabney**, M. Dryzhakov, S. J. Varma, J. Moran, T. Chervy, X. Zhong, E. Devaux, C. Genet, J. Hutchison, and T. W. Ebbesen, Ground state chemical reactivity under vibrational coupling to the vacuum field. *Angew. Chem. Int. Ed.*, 55, 2016, 1-6.

S. Mahajna, M. Neumann, O. Eyal, and **A. Shalabney,** Plasmon-waveguide resonances with enhanced figure of merit and their potential for anisotropic biosensing in the near infrared region. *Journal of Sensors*, 2016.

R. M. A. Vergauwe, J. George, T. Chervy, J. A. Hutchison, **A. Shalabney,** V. Y. Torbeev, and T. W. Ebbesen, Quantum strong coupling with protein vibrational modes. *J. Phys. Chem. Lett.,* 7, 2016, 4159-4164.

S. Wang, S-L. Li, T. Chervy, **A. Shalabney**, S. Azzini, E. Orgiu, J. A. Hurchison, C. Genet, P. Samori, and T. W. Ebbesen, Coherent coupling of WS2 monolayers with metallic photonic nanostructures at room temperature. *Nano Lett., 16*(7), 2016, 4368-4374.

A. Thomas, L. Lethuillier-Karl, K. Nagarajan, J. George, T. Chervy, **A. Shalabney,** E. Devaux, C. Genet, J. Moran, and T. W. Ebbesen, Tilting a ground state reactivity landscape by vibrational strong coupling (submitted to *Science*).

H. Hiura, **A. Shalabney, and** J. George, Cavity catalysis-Accelerating reactions under vibrational strong coupling (submitted to *Science*).

CONFERENCE PROCEEDING PAPERS

A. Karabchevsky and **A. Shalabney**. 2016. Strong interaction of molecular vibrational overtones with near-guided surface plasmon polariton. *SPIE Photonics Europe*, Brussels, Belgium.

INVITED TALKS

2018, College de France, Paris. QED-M2. Symposium on New QED landscapes for molecules and materials. Molecular Vibrational Strong Coupling: Novel Route to Modify Materials Properties.


USA
Nikon

Department of Software Engineering & Information Systems

Dr. Dvora Toledano-Kitai
Head of Department

RESEARCH AREAS

ALGORITHMIC GAME THEORY

Elena Kleiman

Algorithmic Game Theory (AGT) is an area in the intersection of game theory and computer science whose objective is to understand and design algorithms in strategic environments. Typically, in Algorithmic Game Theory problems, the input to a given algorithm is controlled by many players who have a personal incentive in the output. Hence, in addition to the usual requirements in classical algorithm design, like polynomial-time running time, good approximation ratio, etc., the designer must also care about incentive constraints.

We can consider Algorithmic Game Theory from two perspectives:

Analysis: Look at the current implemented algorithms and analyze them using Game Theory tools: calculate and prove properties on their Nash equilibria, price of anarchy, and best-response dynamics.

Design: Design games that have both good game-theoretical and algorithmic properties. This area is called algorithmic mechanism design.

Keywords: Game theory, Nash Equilibria, Price of anarchy, mechanism design

ANALYSIS OF BIG CELLULAR DATA

Katerina Korenblat, Zeev Volkovich, Elena Ravve, Thomas Couronn (Orange Labs – France Telecom R&D), and **Valery Kirzner** (University of Haifa)

The research deals with mining and categorization of big sparse data describing consumers' cellular activity. Methods drawn from the bioinformatics area combined with a novel clustering algorithm make it possible to reveal new users' behavior patterns.

Keywords: Big cellular data, compositional spectra, clustering of big data

ANALYSIS OF MOTOR CONTROL DATA

Anat Dahan and **Hila Gvirts** (Ariel University)

The research deals with identifying deficiencies in motor control and motor planning according to the recording of movement trajectories in neurological disorders. It further deals with applying machine-learning tools for linking data from the domains of motor planning, social motor synchronization, and social cognition.

Keywords: Neurological disorders, motor planning, machine learning

APPLICATION OF KNOWLEDGE ENGINEERING, MODEL-DRIVEN SYSTEMS, AND SOFTWARE ENGINEERING

Zeev Barzily, Mati Golani, and **Avi Soffer**

The engineering discipline of knowledge engineering involves integrating knowledge into computer systems to solve complex problems that normally require a high level of human expertise. This integration is accomplished by building, maintaining, and developing knowledge-based systems. Knowledge engineering has a great deal in common with software engineering and is related to many computer science domains such as artificial intelligence, database systems, data mining, expert systems, decision support systems, and management information systems. Model-driven engineering (MDE) is a software development methodology that focuses on creating models or abstractions related to particular domain concepts. It is meant to increase productivity by maximizing compatibility between systems, simplifying system development and maintenance, and promoting communication between individuals and teams working on the system.

Keywords: Knowledge engineering, model-driven engineering

AUTOMATIC SYSTEM REPAIR VIA AUTOMATA LEARNING

Sarai Sheinvald, Hadar Frenkel (Technion–Israel Institute of Technology), and **Orna Grumberg** (Technion–Israel Institute of Technology)

We present Assume-Guarantee-Repair—a novel framework that not only verifies that a program satisfies a set of properties, but also repairs the program if the verification fails. We consider *communicating programs,* which are simple C-like programs, extended with synchronous communication actions over communication channels.

Our method, which consists of a learning-based approach to assume-guarantee reasoning, fulfills the two tasks simultaneously: in every iteration of the procedure, we either make another step towards proving that the (current) system satisfies the specification, or alter the system in a way that brings it closer to satisfying the specification. We manage to handle infinite-state systems by using a finite abstract representation, and reduce the semantic problems in hand—satisfying complex specifications that also contain first-order constraints—to syntactic ones, namely membership and equivalence queries for regular languages. We demonstrate the effectiveness of AGR on several examples using existing SMT solvers, learning, and reachability analysis tools.

Keywords: Assume-guarantee reasoning, automata learning, system repair

BIN PACKING

Elena Kramer and **Elena Kleiman**

Bin Packing (BP) is one of the most basic problems in theoretical computer science and combinatorial optimization. The classical BP problem asks for the packing of a list of items with sizes from [0,1] into the smallest possible number of bins having unit capacity.

Research of BP and its many variants was motivated by the fact that this abstract problem models a large variety of real world problems such as cutting stock problems (cutting pieces of variable sizes from standard paper sheets, from standard textile cloth measures, etc.), machine scheduling problems (minimizing the number of machines necessary for completing all tasks by a given deadline), and storage allocation problems (allocating space on a disc or in a computer memory).

The problem is known to be NP-hard; thus, research has concentrated on the study and development of approximation algorithms; that is to say, algorithms that do not guarantee to find an optimal solution for every instance, but find near-optimal packings in polynomial time.

A particular class consists of online algorithms that receive their input over time, instead of all at once.

Keywords: Bin packing, online algorithms, offline algorithms

BIOINFORMATICS

Katerina Korenblat, Zeev Volkovich, and **Alex Bolshoy** (University of Haifa)

Research in the field of bioinformatics is focused in two main directions. The first concerns classifying organisms using properties of DNA sequences. The second deals with feature selection in the microarray data arrangement. In particular, the problem of active gene selection in leukemia diagnosis is considered.

Keywords: Genome classification, microarray analysis, features selection

COMBINATORIAL PROPERTY TESTING

Orly Yahalom

Property testing involves the relaxation of decision problems where we wish to decide with high probability whether the input has a given property or is "far" from having it. Interestingly, many properties can be effectively tested by querying only a small fraction of the input. The research is concerned with testing properties of combinatorial objects such as vertex colorings or edge orientations of graphs. We are interested in efficient property testers as well as in the lower bounds of query complexity in testing given problems.

Keywords: Property testing, sublinear algorithms, graph algorithms, randomized algorithms, massively parameterized

DATABASE THEORY

Elena Ravve

Database theory encapsulates a broad range of topics related to the study and research of the theoretical realm of databases and database management systems.

Theoretical aspects of data management include, among other areas, the foundations of query languages, computational complexity and expressive power of queries, finite model theory, database design theory, dependency theory, foundations of concurrency control and database recovery, deductive databases, temporal and spatial databases, real time databases, managing uncertain data and probabilistic databases, and web data.

Keywords: Database, query languages, dependency theory

DATA MINING, CLUSTERIZATION THEORY

Dan Lemberg

Data mining and clustering theory are a fairly large area. My research in these areas focuses on several domains. The first is the construction of the categories of metric spaces for which the clustering algorithms are invariants, and construction of clustering algorithms that are invariants in concrete category of metric spaces. The second is the construction of practical clustering algorithms as text clustering algorithms, etc.

Keywords: Clustering, data mining, text analysis, category theory, metric space

DATA MINING, TEXT MINING

Renata Avros, Mati Golani, Katerina Korenblat, Elena Ravve, Avi Soffer, Dvora Toledano-Kitai, Zeev Volkovich, Orly Yahalom, and **G.-W. Weber** (Institute of Applied Mathematics, Middle East Technical University, Turkey)

Data mining deals with the understanding and interpretation of data as usually presented in large datasets. The main research topic in this area is the cluster validation problem. Resting upon modern statistical and computational tools, several new cluster stability criteria are offered together with applications for text mining problems such as authorship recognition and theme selection.

Keywords: Clustering, feature selection, cluster validation, unsupervised learning

EARLY INTRODUCTION OF ADVANCED COMPUTER SCIENCE TOPICS

Orna Muller, Ayelet Butman (Holon Institute of Technology), and **Moshe Butman** (College of Management)

It is widely agreed that an introductory computer science (CS) course should be about more than just programming. Other aims are acquainting students with concepts and principles of CS and developing students' problem-solving skills. This study is a part of ongoing research and development focusing on instructional design of an introduction to computer science courses, and involves the incorporation of problem-solving strategies explicitly into introductory programming curricula. At this stage, our research looks at advanced concepts and terms used by computer scientists to simplify the description of algorithms and can be used to support beginners when solving algorithmic problems. Early introduction of such concepts exposes students to the nature and the essence of CS and software engineering. The advanced concepts help students reach solutions that are easier to develop, simple to understand, elegant, and in many cases more efficient. Moreover, the real-word problems add interest and create motivation to study CS.

Keywords: Problem solving skills, introduction to computer science, instructional design

FORMAL SOFTWARE AND HARDWARE VERIFICATION

Katerina Korenblat, Sergey Mazin, Elena Ravve, and **Zeev Volkovich**

Formal methods are a particular kind of mathematically-based techniques for specification, development, and verification of software and hardware systems. The use of formal methods for software and hardware design is motivated by the expectation that as in other engineering disciplines, appropriate mathematical analysis can contribute to the reliability and robustness of a design. Formal methods provide fully automated mathematical proofs of correctness. The high cost of using formal methods, however, means that they are usually only used in the development of high-integrity systems, where safety or security is of utmost importance.

Keywords: Program verification, formal methods in software engineering, program logics, BDD, temporal logics, Kripke model

GENERALIZED CONVOLUTION THEORY

Renata Avros, Dvora Toledano-Kitai, and **Zeev Volkovich**

Generalized convolution theory is a notable area of modern probability theory. A new analytical approach in this field has been offered by Volkovich. One of the most well-known realizations of this construction is named the Volkovich Convolution. Recent research studies focus on the search for new analytical tools that will provide a solution for the convolution embedding problem.

Keywords: Generalized convolution, general integral transforms, stochastic modeling

GRAPH POLYNOMIALS

Elena Ravve and **Johann. A. Makowsky** (Technion–Israel Institute of Technology)

f graph parameters (also called numeric graph invariants) are functions from the class of all finite graphs *G* to some numeric domain that is a commutative ring with 0 and 1, usually the integers Z, the rational numbers Q, or the reals R. Graph properties are a special case where the value is 0 or 1. Graph polynomials are *p* functions from *G* into a polynomial ring. Graph polynomials are a way to encode infinitely many graph parameters.

Keywords: Generating function, roots, partition function

INCREMENTAL COMPUTATION

Elena Ravve

Incremental computation is a feature that whenever a piece of data changes, attempts to save time by only recomputing the output that "depends on" the changed data.

Keywords: (Strongly) distributed systems, decomposition, incremental computation, propagation of computations

INFORMATION THEORY AND CODING THEORY

Binyamin Mounits

Research in this area of information and coding theory is concerned with finding upper bounds for the maximal cardinality of codes of a given block length with respect to the minimum hamming distance over finite fields. We search for bounds for the minimum average distance for subsets in metric association schemes. In addition, we seek to develop construction methods for constant weight codes and algebraic geometry codes with improved parameters.

Keywords: Information theory, coding theory, bounds on codes, association schemes

INTELLIGENT INFORMATION SYSTEMS

Mati Golani

We provide advanced modeling techniques that incorporate machine learning mechanisms (such as CBR systems and neural networks), pattern recognition, and mining procedures, to reveal "hidden" knowledge and computerize it.
Application fields: production and service enterprises, health service providers and organizations, and the pharmaceutical industry.

Keywords: Machine learning, healthcare, AI

INTELLIGENT TESTING AND ANALYSIS OF SOFTWARE SYSTEMS

Katerina Korenblat, Avi Soffer, Dvora Toledano-Kitai, Elena Ravve, and **Zeev Volkovich**

Software testing makes it possible to achieve a measure of software quality. The recent growth in the complexity of software systems confronts developers with much greater challenges in ensuring proper system behavior. This field of research, which is of interest to both academic and industrial communities, involves the development of automated techniques for detecting and correcting software errors in complex software systems.
Although the ultimate goal of testing is to find software faults, additional measures are taken to correct the faults. Since tests of complex systems must be executed many times and generate a large amount of data, the application of data mining for this purpose focuses on finding information that makes it possible to reproduce an error and find its root cause. One approach to fault root-cause analysis involves applying and adjusting categorization algorithms in the field of testing. Such an algorithm, for example, makes it possible to analyze the structure of successful tests and detect the differences between these successes and a given failed test. For this purpose, attribute-oriented induction in data mining is explored, as well as other methods for data classification.

Keywords: Software testing, debug, software fault detection, analysis and correction, data mining, categorization algorithms

LARGE GRAPH CLUSTERING

Zakharia Frenkel, Katerina Korenblat, Nissan Levtov, and **Zeev Volkovich**

This research is concerned with the development of efficient algorithmic solutions for optimization problems involving large-scale graphs that represent interactions between entities. We deal mainly with methods for organizing and clustering biological and social networks.

Keywords: Graph clustering, PPI networks, social networks

MANAGING CAPACITY IN DEDUPLICATED STORAGE SYSTEMS

Sarai Sheinvald and **Gala Yadgar** (Technion–Israel Institute of Technology)

Data deduplication is one of the most effective ways to reduce the size of data stored in large scale systems, and is widely used to date. The process of deduplication consists of identifying duplicate chunks of data in different files (including backup versions, virtual machine images, etc.) and storing a single copy of each unique chunk. Our goal in this research is to optimize capacity management and load balancing by providing a framework for making efficient and effective migration decisions.

Our objective is a theoretical and practical framework for identifying the optimal migration plan in a deduplicated system. To the best of our knowledge, only heuristic solutions to this problem have been proposed so far.

We expect that in some very large settings our solution will be too complex for real-time system management. It will, however, benefit the evaluation and development of our practical framework and existing and future heuristic solutions.

Our second objective is a practical framework for identifying the best possible migration plan, under given computational and system-level constraints. We provide a set of methods for reducing the problem's size and complexity and for maximizing the physical and logical locality in the system after migration.

This framework will be readily applicable to realistic system settings and will allow system managers to fine-tune their system's load and capacity, potentially reducing its operational costs and energy consumption. Some of our methods are orthogonal to our ILP approach and will help optimize other existing and future approaches.

Keywords: Deduplication, ILP, storage

OPERATION AND CONTROL OF MANUFACTURING SYSTEMS BY AGENTS WITH LOCAL INTELLIGENCE

Miri Weiss-Cohen, **Michael Mitnovitsky** (Technion–Israel Institute of Technology), and **Moshe Shpitalni** (Technion–Israel Institute of Technology)

The focus is on the development and research of agent-based adaptive control systems that handle resource allocation in a dynamic flow shop with a big variety of uncertainty issues. We study a flexible flow shop problem considering dynamic events such as stochastic job arrivals, uncertain processing times, unexpected machine breakdowns, and the possibility of processing flexibility. The aim is to enable operational flexibility and increase productivity as well as to offer strategic advantages such as analyzing factory development options by using simulation.

Keywords: Multi-agent system, flexible flow shop, dynamic scheduling, task sequencing, resources allocation

PARALLEL SEARCH

Yoav Rodeh and **Amos Korman** (CNRS, Paris, France)

The research deals with the question of designing parallel algorithms for finding a treasure when placed according to a known distribution in one of a number of boxes. Specifically, we focus on the advantages of completely symmetric and non-communicating algorithms, which have very good robustness properties. This question is also examined from a game theoretic perspective and the reward mechanism, which bring about fast search algorithms.

Keywords: Parallel algorithms, Bayesian search, game theory

PHARMACOKINETIC MODELING OF DRUGS

Mati Golani and **Idit Golani**

The blood–brain barrier (BBB) presents a challenge to the pharmaceutical industry. The BBB is a very effective screener of different kinds of bacterial infections. Unfortunately, it also prevents many drugs from penetrating it. An assessment model is required to improve drug development. An effective assessment model can drastically reduce development times by eliminating drugs with low success rates. It can also save considerable amounts of money by directing clinical trials to focus only on drugs that are more likely to succeed.

Keywords: Bioinformatics, neural nets, feature selection

A RECOGNITION SYSTEM FOR MESOTHELIOMA LUNG CANCER – INCORPORATING MACHINE LEARNING METHODOLOGIES FOR STAGE CLASSIFICATION AND 3D RECONSTRUCTION OF CELL VOLUME

Miri Weiss-Cohen, **Daniele Regazzoni** (University of Bergamo), and **Andrea Vitali** (University of Bergamo)

Mesothelioma is a rare but aggressive cancer. The definitive diagnosis of mesothelioma is critical for effective treatment and has important medicolegal significance. However, the definitive diagnosis of mesothelioma is difficult because of the composite epithelial pattern. The most commonly used method by surgeons for pre-surgery planning is using 2D images produced by a CT scanner, MRI scanner, and similar methods. The system is developed to perform in two major aspects: first, to classify all five stages of mesothelioma (the first stage is no cancer) using a convolutional neural network (CNN) with very high accuracy. Second, to create software capable of transforming a series of 2D CT scans into a 3D model representing the lung structure and cancer cells.

Keywords: Computed Tomography, Malignant pleural mesothelioma (MPM), pleural rind, Convolutional Neural Network (CNN), Voxels, NURBS Curves

REQUIREMENTS ENGINEERING

Avi Soffer

Requirements engineering (RE) is the branch of software engineering that focuses on the processes of elicitation, organization, representation, specification, modeling, linking, validation, tracing, and management of requirements in any software development and maintenance effort. RE research involves developing and applying technologies and practices from software and systems engineering, project management, and model-based development fields.

Keywords: Requirements engineering, software engineering, model-based development

SCULPTURED SURFACE COVERAGE OF 3D SOLIDS USING GENETIC ALGORITHMS

Miri Weiss-Cohen

NURBS surfaces are used for 3D solids, given that the solid is arranged on a flat surface. This research seeks to optimize the residue of non-covered surfaces and the gap between the covering 3D solid and the sculptured surface. This optimization involves using genetic algorithms for defining the optimal mesh for the surface.

Keywords: NURBS surfaces, surface coverage

SEQUENCE BIOLOGY

Zakharia Frenkel, Zeev Volkovich, Avi Soffer, and **Edward Trifonov** (University of Haifa)
The research includes development of algorithms for computational analysis of DNA and protein sequences. The main goals of this analysis are sequence annotation and evolutionary studies. The algorithms concern different fields such as text clustering algorithms and algorithms for network analysis.

Keywords: DNA and protein sequence annotation, text mining, network analysis

SOFTWARE ENGINEERING, SYSTEM SPECIFICATION, AND DESIGN METHODOLOGIES

Mati Golani and **Avi Soffer**

Software engineering is concerned with the study and application of a systematic, disciplined, and quantifiable approach to the development, operation, and maintenance of software. It involves using both computer science and engineering principles and practices towards improved handling of requirements, specification, design, implementation, and verification of software systems. It also incorporates database design and optimization, as well as architecture design methodologies. Software engineering research involves developing and applying technologies and practices from computer science, project management,

engineering application domains, interface design, digital asset management, and other such fields.

Keywords: Software engineering, requirements engineering, specification, design

SPATIO-TEMPORAL FORECASTING MODELS FOR RENEWABLE ENERGY SYSTEMS

Miri Weiss-Cohen, **Carlos Severiano** (UFMG-Brazil), and **Frederico Gadelha Guimarães** (UFMG-Brazil)

Renewable energy systems such as solar photovoltaics and wind are sources of energy that are very sensitive to climate variations, which can affect their generation patterns. Forecasting methods can contribute to this task and therefore their application in this area has been widely studied. Forecasting methods usually take as input historical data from the time series generated by the point of interest. For a further improvement in forecasting accuracy, the information available in space has also been added to forecasting methods. These approaches, called spatio-temporal methods, make use of all the available data collected from different locations. In renewables, variations observed at neighbor locations may occur in the near future at some point of interest, since many of these events are the result of climatic phenomena.

Keywords: Spatio-temporal forecasting, renewable energy, fuzzy time series, deep learning

TOPOLOGY AND SHAPE OPTIMIZATION UZING STRESS ANALYSIS AND NURBS CURVES

Miri Weiss-Cohen, **Antonio Caputi** (University of Bergamo), and **Davide Russo** (University of Bergamo)

A novel design methodology is developed that combines topology and shape optimization to define material distribution in the structural design of a truss. New arrangements are constructed by aligning and rotating the original mesh elements coherently to the principal directions. In the Shape Optimization stage, the resulting TO (Topology Optimization) geometry is refined. A process of replacing the tabular mesh is performed by rearranging the remaining elements. The vertices of the mesh are set as control polygon vertices and used as references to define the NURBS (Non-Uniform Rational B-Spline) curves. This provides a parametric representation of the boundaries, outlining the high elastic energy zones. The final stage is the optimization of the continuous and analytically defined NURBS curve outlining the solid material domain. The Shape Optimization is carried out applying a gradient-based optimization method.

Keywords: Topology optimization, shape optimization, NURBS curves, bi-directional evolutionary structural optimization, tension distribution

UPPER EXTREMITY REHABILITATION USING AFFORDABLE MOTION CAPTURE DEVICES AND MACHINE LEARNING METHODOLOGIES

Miri Weiss-Cohen, **Daniele Regazzoni** (University of Bergamo), and **Andrea Vitali** (University of Bergamo)

The research aims to develop a virtual platform for tele-rehabilitation of upper limbs by means of motion capture systems and medical assessment based on both a knowledge-based approach and machine learning. Methods and tools are relative to the design of a solution for medical assessment of upper limb tele-rehabilitation processes. The proposed solution offers the possibility to guarantee a continuative and medical-assisted rehabilitation process through low cost technology, which can be easily exploited at home by involved patients. Furthermore, recorded tracked motion data and results could also be used for further medical study for evaluating rehabilitation trends according to the type of disease of upper limbs. Serious games will be developed to assist patient's rehabilitation practice.

Keywords: Rehabilitation, motion capture, machine learning, patient assessment, gaming

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Department of Teaching and General Studies

Dr. Yael Furman Shaharabani, Ph.D.
Head of Department

RESEARCH AREAS

MERGING TEACHING FOR UNDERSTANDING AND ENGAGING LECTURES IN A PROTEIN ENGINEERING COURSE

Yael Furman-Shaharabani and **Hana Faiger**

Learning protein engineering is a challenge that requires students to understand complex processes. Although research results support active learning, indicating enhanced students' learning, higher education lecturers are accustomed to traditional lecturing, and lectures still prevail in undergraduate studies. This study combines the Engaging Lectures strategy with the Teaching for Understanding (TfU) approach. This mixed methods case study was performed in a Protein Engineering course. The findings indicate that TfU engaging lectures are a beneficial strategy for students and lecturers. This approach enabled a shift towards active learning while maintaining the core content and structure of existing lectures.

Keywords: Instructional change, engaging lectures, teaching for understanding

FROM CONCEPTUAL FRAMEWORKS TO MENTAL MODELS FOR ASTRONOMY

David Pundak, **Ido Liberman** (Western Galilee College), and **Miri Shacham**

This research investigates how college students change their conceptual frameworks and create mental models for astronomy. The study deals with four areas of astronomical knowledge: sky observations, the earth and its orbit, the solar system, and stars.

A new research instrument—Conceptual Frameworks in Astronomy (Pundak, 2016)—is used for this study. The responses of 537 students from three colleges are classified according to four mental models: pre-scientific, geocentric, heliocentric, and stellar/scientific.
The research identified three variables: physics background, mean academic grade, and academic discipline, which contribute to the adoption of the stellar/scientific model. The paper sheds light on the development of astronomical models in higher education.

Keywords: Astronomy, conceptual frameworks, mental models

FROM ENGINEERING TO MATHEMATICS TEACHING: PERCEPTIONS OF MATHEMATICS, MATHEMATICS TEACHING, AND MATHEMATICAL UNDERSTANDING

Ira Raveh and **Yael Furman Shaharabani**

Engineers who choose to change careers and become mathematics teachers are a special group as far as their mathematics learning in the context of engineering and their previous work experience are concerned. Regarding mathematics, they mainly engaged in applied mathematics associated with engineering, which is a highly practical field. It is well known that the perceptions of teachers are somewhat reflected in their teaching. Hence, it is important to study the perceptions and attitudes of this group of future mathematics teachers. This research explores experienced engineers' perceptions of mathematics-teaching related topics, before starting their studies in a pre-service mathematics teacher preparation program. This research explores their perceptions of mathematics as a discipline, mathematics teaching, and mathematical understanding.

Keywords: Career changers, engineers as teachers, mathematics teaching, mathematical understanding

INCORPORATING KAHOOT! IN ENGINEERING CONTENT-HEAVY COURSES

Victor Chernov, **Sivan Klass**, and **Yael Furman-Shaharabani**

Game-based learning is one of the tools to increase learning motivation. Kahoot! is a web based service that allows conducting multiple choice quizzes in which students participate using their web devices. In those quizzes, answers are ranked for correctness and speed. The quizzes are short and provide immediate feedback and rankings. This allows for conducting many of them during the learning period, thus providing continuous feedback and assessment both for the teacher and the student. The gaming factor motivates students to participate and prepare for the quizzes.
This ongoing work examines different models of incorporation of Kahoot! quizzes in the teaching process of three courses: Fluid Mechanics in the Department of Bioengineering, Thermodynamics in the Department of Bioengineering, and Thermodynamics in the Department of Mechanical Engineering.

Keywords: Game based learning, Kahoot!, immediate feedback

MATHEMATICAL AND ENGINEERING UNDERSTANDING: THE PERSPECTIVE OF ENGINEERING STUDENTS

Ira Raveh, **Elena Trotskovsky**, and **Nissim Sabag**

The subject of mathematics has always existed in the very core of engineering education. Engineering students take many courses in mathematics during their qualification for an undergraduate degree in engineering. This study looks into how undergraduate engineering students at ORT Braude College perceive engineering and mathematical understanding—the similarities and differences between them.

Keywords: Understanding, mathematical thinking, engineering thinking

MATHEMATICAL UNDERSTANDING AND ENGINEERING UNDERSTANDING: THE EXPERT PERCEPTIONS

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The notion of understanding has always existed at the core of engineering and mathematical education. Nevertheless, the notion of understanding is neither unequivocal nor well defined. Many studies deal with mathematical understanding, while fewer studies address engineering thinking and understanding, very few deal with students' perceptions of mathematical and engineering understanding, and no studies explore the experts' view of the nature of mathematical and engineering understanding. This study continues the research of Raveh, Trotskovsky, and Sabag (2017) and deals with experts in engineering and mathematics perceptions of engineering understanding and mathematical understanding.

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PRE-SERVICE ENGINEERING AND MATHEMATICS TEACHERS' PERCEPTIONS AND DEVELOPMENT OF "TEACHING FOR UNDERSTANDING"

Yael Furman Shaharabani

Understanding is a main goal of teaching and learning, yet it is not easily achieved. The "teaching for understanding" approach presents a way to focus teachers' attention on their students' understanding when planning their instruction together with paying attention to students' performance. This research explores the development of engineering and mathematics pre-service teachers' perceptions of students' understanding, and their ability to plan understanding-based instruction.

Keywords: Professional development, teaching for understanding, pre-service teachers

ESSENTIAL SKILLS ON-LINE INTERNATIONAL COURSE

Miri Shacham, **Sharon Tidhar**, and **Dvora Toledano-Kitai**

The on-line international course "Essential Skills" was developed in the In2it project funded by Erasmus+. Fourteen higher education institutions from Israel and Europe are taking part in the project that is coordinated by ORT Braude College.

The course aims are to boost students' employability skills and give them a competitive edge in the workplace and perhaps even in life, to enable them to work in an international and virtual atmosphere and to enhance their awareness and sensitivity to cultural differences.

The course deals with five main skills: reflective thinking, teamwork, leadership, creative thinking, and problem solving. One hundred and fifteen students across seven institutions from Israel, England, and Poland participated in this innovative course. The students studied online, in English, and worked in international and multicultural teams.

In this research, we conducted in-depth interviews with fifteen students (from ORT Braude College) and with four developers, regarding course relevance, content, format, and the experience of working in an international multicultural team.

Keywords: Essential skills, on-line course, reflective thinking, problem solving

COACHING PROGRAM FOR ACADEMIC SUCCESS: PROMOTING EQUAL OPPORTUNITIES FOR ENGINEERING STUDENTS

Miri Shacham and **Margalit Ben-Yehuda**

The research examines a special Personal-Academic Coaching (PAC) program for promoting students' self-efficacy and academic success, which was developed and implemented in ORT Braude College, seeking to increase retention and equal opportunities to higher education. The research focuses on the contribution of the coaching program to students' self-efficacy, learning strategies, and academic achievements, and also on the contribution of coaching to the personal and professional development of lecturer-coaches.

Keywords: Coaching, academic success, self-efficacy

ELECTRICAL AND ELECTRONICS ENGINEERING EDUCATION

Nissim Sabag

This research investigates different aspects of engineering education such as problem-based learning and students' motivation, on-line education, mathematical vs. engineering understanding, and learning styles. The research is conducted in collaboration with the Technion–Israel Institute of Technology and other colleagues.

Keywords: Animation based learning, active learning, promote teaching

DOCTORAL LEARNING BETWEEN CULTURES: ENHANCING LIFELONG LEARNING

Yehudit Od-Cohen (Ohalo College) and Miri Shacham

With the increased mobility of international students and of postgraduate programs that facilitate and support them in their learning, a unique phenomenon is emerging, that of doctoral learning between different cultures. Many international doctoral students enter doctoral programs and supervisory arrangements in countries where teaching takes place in English. Consequently, they make a cultural shift, since they undertake their doctoral learning in another country, another language, and another culturally inflected learning context. This research elaborates on the findings that emerged from research focusing on the learning characteristics of international PhD graduates and on the process of lifelong learning (LLL) through and beyond their PhD studies. This research is grounded on the theories of lifelong learning, multicultural learning, and adult learning.

Keywords: Intercultural doctoral learning, lifelong learning, informal adult learning, professional development

THEORY PRACTICE GAP: TEACHERS-AS-LEARNERS QUESTIONS

Yael Furman-Shaharabani and **Anat Yarden** (Weizmann Institute of Science)

The gap between practice and theory is a well-known barrier to educational improvement. There is an ongoing need to understand teachers' thinking and find new ways to connect practice and theory meaningfully. The aim of the research is to explore the ways in which in-service teachers link practice and theory, using teachers-as-learners' questions asked in the context of two academic courses directed at mediating practice and theory. Thirty one experienced biology high school teachers participated in the research.

Keywords: Theory-practice gap, science teachers, in-service, teachers' questions

TEACHERS' KNOWLEDGE OF THE INTERCONNECTIONS BETWEEN THE STANDARD ALGORITHMS OF FOUR ARITHMETIC OPERATIONS AND THEIR UNDERLYING MATHEMATICAL PRINCIPLES

Ira Raveh, **Boris Koichu** (Technion–Israel Institute of Technology), **Orit Zaslavsky** (Technion–Israel Institute of Technology and New York University), **and Irit Peled** (University of Haifa)

This study aims to identify the components of schoolteachers' mathematical knowledge regarding the teaching of standard algorithms, and examines a particular way of promoting their understanding of the mathematical principles underlying the algorithms. The methodological contribution of the study consists of a method for developing operational criteria for identifying and promoting various components of the teachers' knowledge. On the practical level, the findings help in formulating recommendations for improving the ways of teaching the subject, either in professional development programs for teachers or in school settings.

Keywords: Standard algorithms of the four arithmetic operations, mathematical knowledge for teaching

TRANSLATING THE ALGORITHMS OF THE FOUR BASIC ARITHMETIC OPERATIONS INTO HORIZONTAL REPRESENTATION: THE STORY OF ONE TASK

Ira Raveh

This study continues the previous work by Raveh et al. (2016), and focuses on the teachers' learning according to the integrative framework consisting of the core components of the mathematical knowledge essential for teaching the standard algorithms as a holistic and connected subject. The work describes how the teachers' learning process happens and stresses the central role of translating the algorithms into horizontal representation tasks in this process. On the practical level, the findings help in formulating recommendations for designing good learning tasks for promoting teachers' mathematical knowledge for teaching.

Keywords: Standard algorithms of the four arithmetic operations, mathematical knowledge for teaching, task design

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Teaching and Learning Center

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RESEARCH AREAS

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PRE-SERVICE ENGINEERING AND MATHEMATICS TEACHERS' PERCEPTIONS AND DEVELOPMENT OF "TEACHING FOR UNDERSTANDING"

Yael Furman Shaharabani

Understanding is a main goal of teaching and learning, yet it is not easily achieved. The "teaching for understanding" approach presents a way to focus teachers' attention on their students' understanding when planning their instruction, together with paying attention to students' performance. This research explores the development of engineering and mathematics pre-service teachers' perceptions of students' understanding, and their ability to plan understanding-based instruction.

Keywords: Professional development, teaching for understanding, pre-service teachers

ESSENTIAL SKILLS ON-LINE INTERNATIONAL COURSE

Miri Shacham, **Sharon Tidhar**, and **Dvora Toledano-Kitai**

The on-line international course "Essential Skills" was developed in the In2it project funded by Erasmus+. Fourteen higher education institutions from Israel and Europe are participating in the project that is coordinated by ORT Braude College.

The course aims are to boost students' employability skills and give them a competitive edge in the workplace and perhaps even in life, to enable them to work in an international and virtual atmosphere, and to enhance their awareness and sensitivity to cultural differences.

The course deals with five main skills: reflective thinking, teamwork, leadership, creative thinking, and problem solving. One hundred and fifteen students across seven institutions from Israel, England, and Poland participated in this innovative course. The students studied online, in English, and worked in international and multicultural teams.

In the research, we conducted in-depth interviews with fifteen students (from ORT Braude College) and with four developers regarding course relevance, content, format, and the experience of working in an international, multicultural team.

Keywords: Essential skills, on-line course, reflective thinking, problem solving

COACHING PROGRAM FOR ACADEMIC SUCCESS: PROMOTING EQUAL OPPORTUNITIES FOR ENGINEERING STUDENTS

Miri Shacham and **Margalit Ben-Yehuda**

The research examines a special Personal-Academic Coaching (PAC) program for promoting students' self-efficacy and academic success, which was developed and implemented at ORT Braude College, seeking to increase retention and equal opportunities to higher education. The research focuses on the contribution of the coaching program to students' self-efficacy, learning strategies, and academic achievements, and also on the contribution of coaching to the personal and professional development of lecturer-coaches.

Keywords: Coaching, academic success, self-efficacy

ELECTRICAL AND ELECTRONICS ENGINEERING EDUCATION

Nissim Sabag

This research investigates different aspects of engineering education such as problem-based learning and students' motivation, on-line education, mathematical vs. engineering understanding, and learning styles. The research is conducted in collaboration with the Technion–Israel Institute of Technology and colleagues.

Keywords: Animation based learning, active learning, promote teaching

TRANSLATING THE ALGORITHMS OF THE FOUR BASIC ARITHMETIC OPERATIONS INTO HORIZONTAL REPRESENTATION: THE STORY OF ONE TASK

Ira Raveh

This study continues the previous work of Raveh et al. (2016) and focuses on the teachers' learning according to the integrative framework consisting of the core components of the mathematical knowledge essential for teaching the standard algorithms as a holistic and connected subject. The work describes how the teachers' learning process happens, and stresses the central role of translating the algorithms into a horizontal representation task in this process. On the practical level, the findings help in formulating recommendations for designing good learning tasks for promoting teachers' mathematical knowledge for teaching.

Keywords: Standard algorithms of the four arithmetic operations, mathematical knowledge for teaching, task design

PROJECT-BASED SERVICE-LEARNING IN ENGINEERING EDUCATION

Orna Muller (Department of Software Engineering), **Orit Braun Benyamin** (Department of Mechanical Engineering), **Vered Dangur**, and **Noga Shalit** (Teaching and General Studies Unit)

Project-Based Service-Learning involves the development of a product for the benefit of an individual or an organization. This engineering-education study follows ORT Braude College's flagship project in which students develop assistive devices for people with special needs. It uses Grounded Theory Methodology to reveal graduates' perceptions and the long-term impact of the project.

Keywords: Engineering education, project-based service learning, people with special needs, assistive devices, grounded theory

THE EFFECT OF FEEDBACK ON IMPROVING VISUAL ATTENTION SKILLS

Nirit Gavish and **Hagit Krisher** (ORT Braude College – Students' Support Center)

A common cause of reading disorders is visual attention deficit. Research has demonstrated that training using a dedicated training program and protocol can improve visual attention skills and reading abilities. The common method is based on exposing trainees to slow smooth pursuit tracking of fragmented stimuli. This gradual exposure enables the trainees to acquire the needed visual attention skill. Until now, however, training was based solely on bottom-up processes and higher-level cognitive inferences, while top-down processes were not considered. The current research examines whether adding controlled feedback to the training protocol can support top-down processes which, in combination with bottom-up processes, will facilitate learning and skill transfer.

Keywords: Training, visual attention, reading, bottom-up, top-down

USE OF SERIOUS GAMING TO IMPROVE INTELLIGENCE ANALYSIS

Doron Faran and **Nirit Gavish**

The quality of intelligence analyses depends on the analysts' skills. Even though training programs supported by e-learning have shown progress, the creative reasoning skills and reflexes of law enforcement agents are not completely optimized. This research focuses on understanding how analysts use both deduction and induction in their thinking, seeking ways to help them fully exploit their skills, knowledge, experience, and creativity. A computerized training program that addresses the major training needs of analysts will be developed, and the serious gaming approach will be used for this training program.

Keywords: Intelligence, serious gaming, training, analysis

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Y. Furman Shaharabani and **H. Faiger.** Teaching for understanding in an academic course: Experienced lecturer's challenges and benefits. *Presentation at ICERI2017 – 10th International Conference on Education, Research and Innovation*, Seville, Spain, November 2017.

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N. Gavish
International Journal of Human-Computer Interaction
Interactive Learning Environment
International Journal of Advanced Robotic Systems
Journal of Computer Assisted Learning
Journal of Educational Computing Research
Cognition Technology & Work
PLOS ONE
Cognition
Multimodal Technologies and Interact

INVITED TALKS

O. Muller. Engineers as second-career teachers: the impact of previous career on pedagogy, in a *symposium on Teacher Education in (Trans)Formation: Global Trends, National Processes and Local Factors,* Technische Universität Dresden, Germany, November 12-16, 2018.

M. Shacham. A model of course design. *Encounter of coaches in the Ministry of Education's Program: Schools Leading Quality Pedagogy*, Tel Aviv, Israel, March 2018.

The English Studies Unit

Dr. Linda Weinberg
Head of Unit

RESEARCH AREAS

ENGLISH MEDIUM INSTRUCTION

Linda Weinberg, **Samantha Curle** (University of Bath, England), **Sonia Munteanu** (Technical University of Cluj-Napoca, Romania)

In Israel, student and lecturer needs for learning and teaching in English are not systematically addressed and a consistent policy regarding the necessary preparation and support within the curriculum has yet to be developed. This study investigates the implications of teaching content courses in English in Israeli institutions of higher education and draws conclusions from European policy aimed at improving proficiency in English.

Keywords: Language learning, English medium instruction, internationalization

LEARNER MOTIVATION AND AUTONOMY IN TECHNOLOGY-ENHANCED LANGUAGE LEARNING CONTEXTS

Linda Weinberg

Why can some people learn a second or a foreign language easily while others find it almost impossible? This longitudinal study focuses on student attitudes towards computer technology in the language learning classroom and is particularly concerned with identifying those factors in a technologically-enhanced language learning environment that might enhance learner motivation while concurrently exploring the relationship between motivation and an autonomous learning capacity.

Keywords: English proficiency, learning and teaching in English, curriculum support, policy

CHILDREN'S LITERATURE

Lauren Berman

This research focuses on children's literature in general and on J. K. Rowling's Harry Potter series, specifically. Several articles discuss the demonic motifs and the philosophy of evil in Rowling's works, while the latest research is on socio-cultural analysis of fairytales.

Keywords: Children's literature, Harry Potter, philosophy of evil, fairytales

MOBILE LEARNING

Lauren Berman

One area of interest is mobile learning and the use of mobile devices—i.e., tablets and iPads—in the classroom, focusing on content creation, collaborative learning, personalized learning and flipping the classroom. Other areas include the creation and use of digital content as well as the evaluation of learning applications and their suitability in the language-learning classroom.

Keywords: Mobile learning, digital skills, iPads and tablets

ENGLISH MEDIUM INSTRUCTION

Lauren Berman

Research conducted on the basis of the English Medium Instruction course on Myths and Legends taught in the Department of General Studies between 2011 and 2018 determines the extent to which students' preexisting knowledge of the English language affected their success in an EMI course.

Keywords: English medium instruction, problem-based learning

CONFERENCES, WORKSHOPS, & SEMINARS

June 7th, 2016, ORT Braude College, Israel. **English Medium Instruction – Introductory Seminar.** This introductory seminar discussed theoretical and practical aspects of teaching content courses in a foreign language. It was specifically developed for lecturers who would be teaching their courses in English.

September 22nd, 2016, ORT Braude College, Israel. **Professional Development Workshop for English Medium Instruction**.
In accordance with the move towards internationalization in institutions of higher education in Israel, departments need to offer more content courses in English. This workshop introduced EFL teachers to the concept of English Medium Instruction (EMI) and to a new role for the EAP departments in developing the necessary support infrastructure for students and lecturers.

12th September, 2016, ORT Braude College, Israel. **Assessment according to the Common European Framework for Language Learning.**
This practical workshop focused on the standardization of assessment practices for speaking and writing tasks according to the CEFR.

ACCEPTED FOR PUBLICATION

E. Spector-Cohen, L. Amdur, I. Barth, O. Inbar-Lourie, I. Or, R. Sitman, and **L. Weinberg.** Towards English for academic purposes curriculum reform: Linguistic, education or political considerations? In Reinders, H., Littlejohn, A., Coombe, C., & Tafazoli, D. Innovation in Language Learning and Teaching: The Case of the Middle East & North Africa. Palgrave Macmillan.

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E. Spector-Cohen, L. Amdur, **L Weinberg**. Towards Internationalization: A CEFR-Aligned Framework for English In Higher Education. Symposium. *ECOSTAR and the CEFR-Aligned Framework for English in Higher Education*. Tel Aviv University, January 5th, 2017.

L. Weinberg and O. Inbar-Lourie, Practical applications of the CEFR in Israel: From EAP to EMI. *The Common European Framework of Reference (CEFR) Fourth Symposium*. Tel Aviv University, May 4, 2017.

L. Weinberg. The TEMPUS ECOSTAR project. *H-INET International Spring Conference*. Tel Aviv University, 8-9 February, 2016.

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