

19<sup>th</sup> Miklós Iványi International  
**PhD**LA  
symposium

Hungary, Pécs, 2-3 November 2023

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**ABSTRACT**BOOK



UNIVERSITY OF PÉCS  
Faculty of Engineering and  
Information Technology

**Abstract book for the  
19th MIKLÓS IVÁNYI  
INTERNATIONAL  
PHD & DLA SYMPOSIUM**

**Abstract book for the  
19th MIKLÓS IVÁNYI  
INTERNATIONAL  
PHD & DLA SYMPOSIUM**

ARCHITECTURAL, ENGINEERING AND  
INFORMATION SCIENCES

*Edited by*  
**Prof. Dr. Péter IVÁNYI**

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University of Pécs**

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# Salute

The 19th Miklós Iványi International PhD & DLA Symposium is one of the most important scientific events at the Faculty of Engineering and Information Technology, University of Pécs. The Faculty hosts the meeting for young researchers and their professors. After the loss of the founder of this Symposium, Prof. Miklós Iványi, it has been decided to honour his memories and therefore this event will be named as “Miklós Iványi International PhD & DLA Symposium”.

This is the 19th year that the PhD & DLA Symposium gives an opportunity to present the achievements of young researchers, to exchange information about the researches of the international partner institutions and to exchange valuable professional experiences and cultivate real friendships.

At the end let me greet the participants of the 19th Miklós Iványi International PhD & DLA Symposium and express my thanks to the organizers for their activity and to the participants of the former and this year’s PhD & DLA Symposium to present papers. At the same time I wish you the best to continue with successful work.

Prof. Dr. Habil Gabriella MEDVEGY, DLA  
Dean  
Faculty of Engineering and Information Technology  
University of Pécs



# Foreword

The 19th Miklós Iványi International PhD & DLA Symposium is organized because it is thought that PhD & DLA students need a special forum in addition to their PhD & DLA program to present the results of their ongoing research. Furthermore the results should be discussed collecting proposals how to continue the work. The First, Second, Third, Fourth, Fifth, Sixth, Seventh, Eighth, Ninth, Tenth, Eleventh, Twelfth, Thirteenth, Fourteenth, Fifteenth, Sixteenth and Seventeenth, Eighteenth International PhD & DLA Symposia were organized in 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021 and 2022 and it is important to continue this tradition. Objectives of the PhD & DLA Symposium:

- to provide a forum for PhD & DLA students in engineering to present the progress of their work;
- to discuss the results of the ongoing PhD & DLA studies in order to support the future activity;
- to give the opportunity for PhD & DLA students to establish contact for international communication;
- to compare PhD & DLA studies in various countries.

The system of this symposium is to have oral presentations by the PhD & DLA students themselves, which are immediately followed by discussions that are scheduled in the program. Main results of the studies are summarized in the Pollack Periodica (an International Journal for Engineering and Information Sciences) published by Akadémiai Kiadó.

On behalf of the Organizing Committee, I would like to express thanks to the University of Pécs, Faculty of Engineering and Information Technology for hosting the Symposium.

Prof. Dr. Habil Péter IVÁNYI, PhD



# International Scientific Committee

BACHMANN, Bálint	Hungary	KŐVÁRI, Bence	Hungary
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KATONA, Tamás	Hungary	SZŰCS, István	Hungary
KMET, Stanislav	Slovakia	TOPPING, Barry	United Kingdom
KÓCZY, László	Hungary	VÁRADY, Géza	Hungary
KOREN, Csaba	Hungary	ZOLTÁN, Erzsébet	Hungary

# Conference program

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## **Day 1:** Thursday 2 Nov 2023

**08:00-12:00** Registration desk open

**09:10-9:55** Conference opening

**9:55-10:00** Group photo

**10:00-12:00** Conference session

**12:00-13:00** Lunch (Room B224, second floor) - *admission by ticket*

**13:00-15:00** Conference session

**15:00-15:45** Coffee / Tea Break

**15:30-17:30** Conference session

**19:00-21:00** Conference dinner,  
Tettye Vendéglő Restaurant (Pécs, Tettye tér 4, 7625) - *admission by ticket*

## **Day 2:** Friday 3 Nov 2023

**09:00-10:00** Conference session

**10:00-10:30** Coffee / Tea Break

**10:30-12:30** Conference session

**12:00-13:00** Lunch (Room B224, second floor) - *admission by ticket*

## Conference program

### Day 1, Thursday

Time	Room A008
09:10-9:55	Conference opening, Opening and plenary lectures page 3

### Day 1, Thursday

Time	Room A008	Room A015	Room A017
10:00-12:00	Architecture 1 page 4	Architecture 2 page 5	Informatics page 6
12:00-13:00	Lunch		
13:00-15:00	Architecture 3 page 7	Civil Engineering 1 page 8	-
15:00-15:45	Coffee Break		
15:30-17:30	Architecture 4 page 9	Civil Engineering 2 page 10	-

### Day 2, Friday

Time	Room A019	Room A015	Room -
9:00-10:00	Architecture 5 page 11	Engineering 1 page 12	-
10:00-10:30	Coffee Break		
10:30-12:30	Architecture 6 page 13	Engineering 2 page 14	-
12:00-13:00	Lunch		

**Day 1: Thursday, 2 Nov 2023: AM, Room A008**

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**09:10-9:55**

**Conference opening**

Professor P. Iványi  
University of Pécs

Professor Gabriella Medvegy  
Dean of the Faculty of Engineering and Information Technology  
University of Pécs

**In-memoriam lectures**

In memoriam Professor Miklós Iványi  
Dr. László Horváth

Professor Miklós Iványi: An Appreciation  
Professor Barry H.V. Topping

Integrating Experimental Studies in Structural Steel Research and Education  
Professor Jenő Balogh

**09:55-10:00**

Group photo in front of the building



**Day 1: Thursday, 2 Nov 2023: AM, Room A008**

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**10:00-12:00**

**Architecture 1**

Chaired by dr. Krisztián Kovács-Andor and dr. Péter Zilahi

**P-6** Study on Ageing Renewal Strategies for Public Spaces in Older Communities

X. Hu, W. Shang, X. Jin

**P-7** “Signal Envelope”: Urban Interface and Public Space Design Strategies Based on Millimeter-Wave Adaptation

T. Hu, T. Wang, Á. Borsos, G. Medvegy

**P-8** Co-design and Service Design for Sustainable Nature-Based Solutions Implementation

F. Tapia, A. Reith

**P-9** Impact of Collaborative Design on Rural Sustainable Development in Hungary

K. Varjú, L. Gyüre, P. Zilahi, D. Rétfalvi

**P-10** Adaptive Design of University-built Libraries in the Digital Age

S. Liu, H. Liu, K. Kovács-Andor

**P-11** The Application of Emotional Design in Lighting for Healthcare Spaces

Z. Fu, D. Rétfalvi

**P-12** Design of Light Environment in Art Museums Based on Quantification of Emotion

C. N. Liu

**P-13** Architectural Reconstruction and Presentation of the Peristyl House of Aquincum through Augmented Reality

A. Timár

**12:00-13:00: Lunch**

**Day 1: Thursday, 2 Nov 2023: AM, Room A015**

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**10:00-12:00**

**Architecture 2**

Chaired by dr. Erzsébet Szeréna Zoltán and Prof. Ágnes Borsos

**P-14** Modular Design of Teaching Interior Space

F. Meng, Y. Cao, B. Bachmann, X. Jin

**P-15** Interior Designs with Architectural Design Thinking

X. Kang, G. Medvegy, Y. Zhou

**P-16** The Biomimicry Approach for Enhancing Energy Efficiency in Office Buildings in Iraq

T. R. Fattah

**P-17** GRID System and Its Flexibility - Considering the Practical Implementation of the Grid System Design Method and Modular Structures in Office Buildings to Enhance Adaptability and Flexibility

D. M. A. Abu-Lail, E. S. Zoltán

**P-18** A Renewal Design in an Office Space under the Concept of Sharing

H. Pan, G. Z. Zheng, Á. Hutter, F. Meng

**P-19** Research on the Optimization Strategy of School Path Space under the Guidance of Child-Friendly Concept and Behavior Pattern

P. Ye, W. Shang, F. Meng

**P-20** Enhancing Educational Environments: A Systematic Literature Review of Indoor Environmental Quality in Classroom Settings

D. S. Khoshnaw

**P-21** Health, Relationship, Empathy - A Practical Study on the Construction of Positive Preschool Education Space

H. Cao, J. Feng

**12:00-13:00: Lunch**

**Day 1: Thursday, 2 Nov 2023: AM, Room A017**

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**10:00-12:15**

**Informatics**

Chaired by Prof. Frederic Magoules

**P-65** Solving a Final Exam Scheduling Problem with Constraint Programming  
L. K. Trautsch, B. Kővári

**P-66** Adaptive Spatial Sensing Using a Multi Camera System  
B. Sebők-Tornai, G. Várady, L. Czúni

**P-67** Hyperspectral Imaging Technique for Underwater Mineral Detection  
M. Koba, L. Czap

**P-68** The Determination of the Line of Interest in a Line Scan Camera-based Measurement System  
Z. Forgács, A. Trohák

**P-69** Implementation of Heating Control for a Family House Using Wago PFC200 Controller and IoT Temperature Transmitters  
R. Simon, A. Trohák

**P-70** Intelligent Computational Method for Temperature Distribution Analysis  
Á. G. Móré, A. Trohák

**P-71** Analytical Examination of PI Control Variation during PLC CPU Replacement  
Á. Móré, A. Trohák

**P-72** A Dashboard for the Comprehension of Move Semantics in C++ Source Code  
A. Gyén, D. Kolozsvári, N. Pataki

**P-73** Construction and Recognition Research of the Feature Model for Multi-Identity Spammer on Bilibili  
Z. Zhao, Y. Zhang

**12:00-13:00: Lunch**

**Day 1: Thursday, 2 Nov 2023: PM, Room A008**

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**13:00-15:00**

**Architecture 3**

Chaired by dr. Anna Mária Tamás and dr. Tamás Molnár

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X. Wang, L. Zhao

**P-23** The Creation of Situational Experience in Consumption Space

J. Sun, L. Zhao

**P-24** The Role of Artistic Collaboration in Contemporary Architectural Praxis

R. Jahoda

**P-25** Imaging Methods and Creating Illusions in the Practice of Architectural Design in the 21st Century

Á. Bíró

**P-26** The Experimental Analysis of the Built Environment of Hiking Trails

I. Manhertz

**P-27** Urban Color Landscape Planning under the Two-tier Relationship - A Case Study of Urban Color Planning in Beijiao Town, Shunde City

Z. Renkun, A. M. Tamás

**P-28** A Comprehensive Scoping Review Methodology for Exploring Living Labs in Architectural Research

N. Kokai, D. Rétfalvi

**P-29** Bonding, Personalization, Storytelling, Ritual: Experiments in Sustainable Furniture Design

D. M. Pataki

**15:00-15:45: Coffee break**

**Day 1: Thursday, 2 Nov 2023: PM, Room A015**

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**13:00-15:30**

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Chaired by Prof. Barry Topping and Prof. János Lógó

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M. Habashneh, M. Movahedi Rad

**P-48** Model Factor for Patch Loading Resistance of Steel Plated Structures

E. Bärnkopf, B. G. Kövesdi

**P-49** Numerical Modelling of the Shear-lag Effect in Tensioned GFRP Bars

S. Szinvai, T. Kovács

**P-50** An Experimental Evaluation of the Effects of Geometric Imperfections and Misalignment of Connection Elements on the Lateral Stability of an Assembled Precast Prestressed Reinforced Concrete Beam

W. S. Hameedi, I. Volgyi

**P-51** Retrofitting of Structures Subjected to Seismic Activities

M. U. Farooq, A. Salem, S. Elhadad, Z. Orban

**P-52** Resilient Design of Structures Subjected to Extreme Effects

S. M. Elqudah, L. G. Vigh

**P-53** Prototyping and Testing of a Low-cost Indoor Mapping System

J. Brindza, J. Erdélyi, P. Kyrinovič

**P-54** Software Solution for Automated Verification of Wall Structures Written in Python

A. Madiiev, J. Erdélyi, R. Honti

**P-55** Automated Pointcloud Processes for BIM Methodology Purposes

V. N. Rácz, P. M. Mader, M. Altamimi

**P-56** Developing More Accurate UA-based Stereo-photogrammetry Methods

O. Rák, N. Bakai, J. Etlinger

**15:00-15:45: Coffee break**

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**P-32** Xinhua News Agency Comprehensive Renovation Project of No.3, Yangfangdian Road, Haidian District  
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**P-33** Revival Heritage Story: A Revitalization Journey of Transforming the Historical Houses  
W. A. S. Goriel, Z. Erzsébet, T. Molnár

**P-34** Rehabilitation of Vernacular Architectural Monuments  
J. Bertalan

**P-35** Research on Reconstruction Design of Diaojiaolou Residential in Guizhou China Terraced Field  
Q. Cui, P. Zilahi

**P-36** Adapting Mongolian Yurts for Modern Lifestyles: A Comprehensive Case Study  
A. Saruul, G. Tsovoodavaa

**P-37** Contemporary Approach to Preserve and Repurpose Mongolian Temples  
E. Gombo-Ochir, T. Molnár

**P-38** Architecture Without Architects in the 21st Century  
T. Z. Dányi

**15:30-17:30**

**Civil Engineering 2**

Chaired by Prof. Csaba Koren and Prof. Andrej Soltész

- P-57** Adaptation of the Method of Road Safety Inspection to Railway Level Crossings  
M. Ladich, D. Miletics
- P-58** The Impact of Public Transport on the Level of Development of Small Villages  
M. Trexler
- P-59** Non-Destructive Detection of Algal Biomass on Building Material Surfaces  
H. Heinrich
- P-60** Water Retention Equipment in the Urbanized Areas  
A. Raczková, R. Wittmanová, J. Hrudka, I. Škultétyová
- P-61** Mathematical Modeling of Surface Runoff for Optimization of Sewer Network Operation  
A. Kollár, M. Meliška, R. Wittmanová, Š. Stanko
- P-62** Analysis of the Operation of Domestic Wastewater Treatment Plants  
M. Meliška, A. Kollár, J. Hrudka, Š. Stanko
- P-63** Sustainable Wastewater Management in Conditions of Slovak Republic  
R. Awad, R. Wittmanová, Š. Stanko, I. Škultétyová, J. Hrudka
- P-64** Unsaturated Groundwater Flow in the Szigetköz Region  
A. Gharbi

**Day 2:** Friday, 3 Nov 2023: **AM, Room** A019

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**09:00-10:15**

**Architecture 5**

Chaired by dr. András Greg and Prof. Mirjana Devetakovic

**P-1** Enriching Architectural Education with Extracurricular Activities - the Case of the Geometry Adventure Workshop

M. Devetaković, J. Ivanović, D. Djordjević, N. Popović

**P-2** Wooden Structures Used As Primary Construction Materials with Optimized Building Designs for Low Carbon Footprint and Long Building Lifetime

P. Markus

**P-3** The Practice of Mortise and Tenon Construction in the Basic Lesson of Architectural/furniture Design

X. Jin, T. Wang, Z. Jin

**P-4** One Step Closer to Sustainability: 3D Printing Technology in Architecture Using Recycled Solid Waste As Raw Material

H. Cao, J. Duan

**P-5** Energy Efficiency and Viability of 3D Printing Technology in Concrete Construction

S. Mohammed Elhadad

**10:00-10:30: Coffee Break**



**Day 2:** Friday, 3 Nov 2023: **AM, Room** A015

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**09:00-10:00**

**Engineering 1**

Chaired by Prof. Drazan Kozak

**P-81** Investigation of the Surface Oxide Layer and Pitting Corrosion Susceptibility of an Aluminium Alloy Produced by Additive Technology Using Electrochemical Methods  
Z. Meiszerics, G. Vasvári, D. Csonka, T. Zsebe

**P-82** A Novel Test Method for Analyzing the Scratching Behaviour of Polycrystalline Diamond Coatings  
P. Jalalova, M. Berkes Maros

**P-83** Hazardous Area Classification by Testing the Explosion Characteristics of Different Natural Gas Mixtures  
L. Tugyi, A. Bakó, V. Mikáczó, T. Pusztai

**P-84** Development of a Coupled Multibody Dynamics Model for Racing Go-Karts Considering Frame Flexibility  
K. Horváth, A. Zelei

**10:00-10:30: Coffee Break**

**Day 2: Friday, 3 Nov 2023: AM, Room A019**

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**10:30-12:30**

**Architecture 6**

Chaired by dr. Gergő Sztranyák and dr. János Gyergyák

**P-39** Study on Updating Strategies of Transforming from an Old Industrial Estate to an Industrial Heritage Community

J. Tan, Á. Hutter

**P-40** Master Plan Applying Possibilities in the Hungarian Urban Development Environment and Regulatory Practice

A. B. Sütő

**P-41** The Reconditioning of the Market Hall of Pécs in the Context of the Sustainability - Environmental Emergency and Architecture through an Academic Semester

A. Greg, G. Veres

**P-42** The Image of the City from the Perspective of the Medium

L. Zhao, T. Wang, J. Gyergyák

**P-43** Water Management of the Green Gate Project in Pécs City, Hungary

L. Ben Khadra

**P-44** Achieving Adaptability through Various Urban Housing Typologies

H. T. Tomajian, D. Ojo, J. Gyergyák, Á. Borsos

**P-45** From Ideal to Reality - Systematic Innovation and Exploration Practice of “Future Community” in Zhejiang, China

S. Wang, J. Yu, X. Jin

**P-46** The Bridge Between Product Design and Architecture in the Context of Building Facades

R. Árpás

**12:00-13:00: Lunch**

**Day 2: Friday, 3 Nov 2023: AM, Room A019**

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**10:30-12:15**

**Engineering 2**

Chaired by Prof. Drazan Kozak

**P-74** Numerical Investigation of Generated Turbulence Flow in Different Types of Corrugation Channel

A. Tanougast, K. Hriczó

**P-75** The Effect of Mixing Hydrogen Gas with Natural Gas on the Heating of Gas Storage Gas Equipment

E. Lévai

**P-76** Comparative Analysis of the Machinability of Thermally Sprayed Cylinder Coatings Made from Base Powders of Different Producers

Á. L. Kókai, P. D. M. B. Dr. Marosné

**P-77** Tube-Fin Contact Material Assesment in Heat Exchangers

L. Budulski, G. Loch, L. Lenkovics, M. Baumann, B. Cakó, T. Zsebe, Z. Meiszterics, D. Csonka, G. F. Vasvári, N. B. Vasváry-Nádor, T. Bitó, G. Várady

**P-78** The Effect of Physical Parameters with Intensive Fluctuation on Thermal Comfort

L. Lenkovics, B. Lenkovics, M. Eördöghné Miklós

**P-79** The Relationship Between PMV-PPD and Work Performance in an Office Environment

L. Lenkovics, B. Lenkovics, M. Eördöghné Miklós

**P-80** Thermal Testing of Heatable Glazing

G. Loch, L. Budulski, L. Lenkovics, B. Cakó, M. Baumann, Á. Borsos

**12:00-13:00: Lunch**

**In memoriam**



## Tribute 1



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Abstract book for the

19th Miklós Iványi International PhD & DLA Symposium

Péter IVÁNYI (Editor),

ISBN 978-963-626-182-5, Lecture 1, 2023.

# Remembering Professor Miklós Iványi: A Decade of Tribute

**Peter Iványi<sup>1</sup> and Amália Iványi<sup>2</sup>**

<sup>1</sup> *Department of Systems and Software Technologies, Faculty of Engineering and Information Technology, University of Pécs, Hungary*

<sup>2</sup> *Department of Technical Informatics, Faculty of Engineering and Information Technology, University of Pécs, Hungary*

Prof. Dr. Miklos Ivanyi  
1940-2013



It is with solemn remembrance that we pay tribute to Prof. Miklos Iványi, who, in the year 1963, embarked upon a distinguished career, joining the Department of Steel Structures at the Faculty of Civil Engineering, Budapest University of Technology and Economics. He dedicated four decades of his life to this profession, leaving a mark on its advancement. In his final ten years of service, he brought his expertise to the Faculty of Engineering and Information Technology at the University of Pécs, where his contribution continued.

Prof. Miklos Iványi departed from our midst on December 21, 2013, having lived a remarkable 73 years. His departure has left a void in the world of engineering and education, but his legacy endures, an everlasting testament to his enduring contributions and dedication.

## The Professor

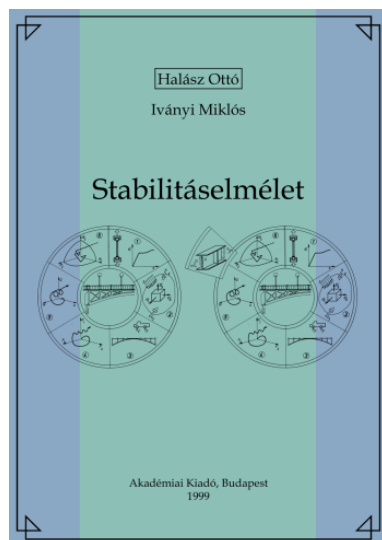
His scientific interest was on Steel and Steel-concrete Composite Structures: stability and ductility of steel structures; behavior of structural joints; fatigue of steel structures; refurbishment of structures. He worked on Computational Steel Structures Technology: stability and

strength of steel structures by finite element analysis. He evaluated several Experimental Tests of Structures: reduced and full-scale tests.

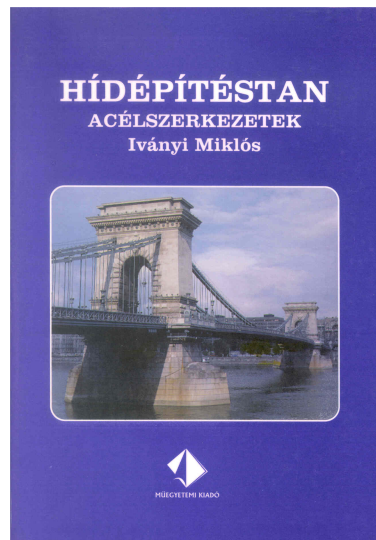
As a member of universities his teaching activities were: undergraduate, graduate and post-graduate courses in Steel Structures, Steel and Composite Bridges, Steel Buildings, Stability Problems of Steel Structures, Plasticity Problems of Steel Structures in Hungarian and English languages.

From 1997-2008 years Prof. Mikos Ivanyi with his Department of Steel Structures, Faculty of Civil Engineering, Budapest University of Technology, Hungary participated in the European educational and research projects - which has the aims to modernize the university level education both on content and methodology - were to harmonize the teaching materials, regarding to the requirements of the industrial and the engineering life and to help the initiation and the familiarization of the Eurocodes. He took part in several international projects (Leonardo da Vinci Programs and TEMPUS JEP ones). In the frame of this activity several books, lecture notes, CD materials have been created:

- Ottó Halász and Miklós Iványi: Stability Theory (in Hungarian), Principles and Methods for Design of Steel Structures. Akadémiai Kiadó, Budapest, 2001, p. 1240. (Fig. 1.1a)
- Miklós Iványi: Bridge Construction, Steel Structures (in Hungarian). Műegyetemi Kiadó, Budapest, 1998, p. 630. (Fig. 1.1b)
- Miklós Iványi, Péter Iványi: EUROCODE-Manual, Design of multi-storey steel buildings (in Hungarian). Pollack Press, Pécs, 2008, p. 414. (Fig. 1.2a)
- Miklós Iványi, László Horváth, Miklós Iványi Jr.: Case Studies of Steel Structures (in Hungarian). Pollack Press, Pécs, 2008, p. 110. (Fig. 1.2b)

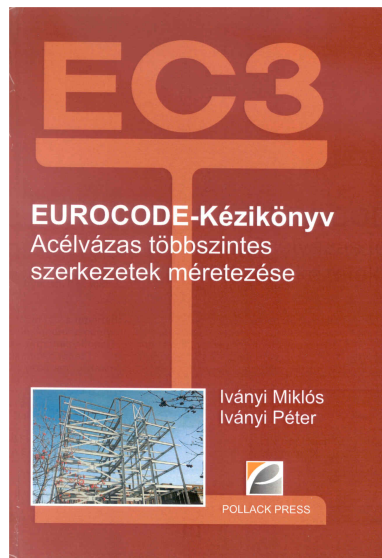


(a) Stability theory



(b) Bridge construction

Figure 1.1



(a) Design of multi-storey steel buildings



(b) Case studies of steel structures

Figure 1.2

## The Scientist

With the gradual development of rules for designing against instability, the idea emerged to hold an International Colloquia on Stability treating every aspect of structural instability of steel structures. International schools were organized in Budapest and at the International Centre of Mechanical Sciences in Udine, Italy. These schools were intended to provide a forum for an international exchange of new knowledge, for making closer contacts among more experienced and younger researchers and structural engineers, and to offer the opportunity for personal discussions. For each of the courses, a volume containing the lecture notes provided by the lecturers were issued.

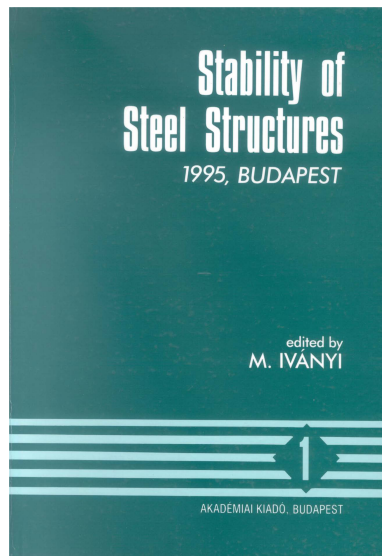
It was later proposed to enlarge Colloquium in Hungary. The goals of the Colloquia were to consolidate the status of the available knowledge and to plan and priorities the need for future research. Problems in applying existing stability design criteria have been created by the use of higher-strength materials used in more open-framed structures, unique architectural layouts, analytical computing capabilities, and an information explosion in stability-related publications.

- M. Iványi, ed. Stability of steel structures, vols 1 and 2. Budapest: Akadémiai Kiadó, 1995. Fig. 1.3)

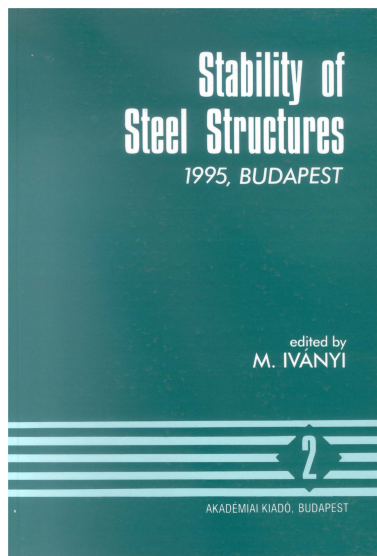
Prof. Mikos Ivanyi has also an interest in bridges. By his proposal a conference series has been started since 1992 entitled "Bridges on the Danube". The conference series was based upon a wide cooperation of universities and other institutes in the Danube region. It has provided opportunities to scholars, tutors and practitioners of technical and historical disciplines respectively to exchange their ideas, opinions, observations and scientific results as well.

On the occasion of these conferences a collection of the Danube bridges had been initiated. The catalogue comprises the major details, diagrams, photographs and descriptions of the designing and constructing phases of the bridges on the Danube in English. The first part of





(a)



(b)

Figure 1.3: Fourth Hungarian Colloquium

the CD comprises a catalogue of the bridges on the Danube, while the second part is a brief summary of the built structures.

- Bridges on the Danube, CD Catalogue, Editor-in-Chief: Prof. Miklós Iványi, 1998. (Fig. 1.4)



Figure 1.4: Catalogue of Danube Bridges

## Tribute 2



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Abstract book for the

19th Miklós Iványi International PhD & DLA Symposium

Péter IVÁNYI (Editor),

ISBN 978-963-626-182-5, Lecture 2, 2023.

# Generalized Analysis of Composite Cross-Sections

Aarne Jutila

*em. Professor of Bridge Engineering, Finland*

**To the Honour of the late Prof. Dr Miklós Iványi**

## Preface

The present author had the honour to get acquainted with Prof. Dr Miklós Iványi in the 14th IABSE Congress garden party in New Delhi, India, in March 1992. A mutual sympathy, friendship and professional interest was at once created. Due to that, frequent series of lectures and mutual visits resulted in Hungary and Finland. A remarkable step was achieved, when a bilateral agreement within the Socrates Programme between the Technical Universities of Budapest and Helsinki was signed in September 1998. Part of that was later extended to cover also Oulu University in Finland and Tallinn University of Technology in Estonia. In all that activity Professor Iványi plaid the key role.

Besides individual presentations, three doctoral lecture courses on orthotropic steel bridges are worth of mentioning. Two of them were arranged at Helsinki University of Technology (HUT) in April 2002 and 2003, respectively, and the last one, a two-weeks course, partly at HUT and partly in Oulu, in December 2006. These courses formed a prominent part of doctoral studies at both universities in Finland. Fig. 2.1.



Figure 2.1: Professor Miklós Iványi lecturing at Oulu University, Finland, in April 2001.

One more remarkable contribution still to mention is the “Bridges on the Danube Catalogue”, published in 1993, where Professor Miklós Iványi was the Editor-in Chief. This extensive catalogue gives a comprehensive picture of the bridges built over the Danube in Central and Eastern Europe. It forms an essential guide to all those, who possess only inadequate knowledge of the Danube Basin.

Professor Miklós Iványi was a cheerful and positive person, to whom it was no difficulty to bind relationship with other people. Because of that and his widely known scientific contributions it is no wonder that he was easily able to form both domestic and international relations. A good example of the latter ones is the fruitful scientific and friendship cooperation of four well-known bridge and structural engineering professors coming from Finland, Hungary, Japan and Slovakia, where, again, Professor Miklós Iványi's role was essential. Fig. 2.2.



Figure 2.2: Dr Herbert Träger, Prof. Aarne Jutila and Prof. Miklós Iványi on the 5th International Danube Bridge Conference Dinner in Budapest in September 2007.  
Foto: Victor Popa, Romania.

## Summary of the Technical Part Underneath

Steel-concrete composite bridge design was considerably advanced, when several studies and books related to composite action were published in the 1950's and early 1960's. Especially worth of mentioning are Sattler's "Theorie der Verbundkonstruktionen" 1952, Hawranek and Steinhardt's "Theorie und Berechnung von Stahlbrücken" 1958 and Fritz's "Verbundträger" 1961. All these books handle only four materials at the most: concrete, steel, reinforcing steel and prestressing steel. However, the theory behind can be extended to any amount of materials, and that is what is done in the present paper. That is why we can speak about a generalized theory. Additionally, stiffness values are used instead of rigidity values, which makes the mathematical formulation simpler compared especially to Hawranek's formulation. Finally, a sign mistake in one of Fritz's main formulas is pointed out.

## 2.1 Background

Three German books, Sattler's "Theorie der Verbundkonstruktionen", Hawranek and Steinhardt's "Theorie und Berechnung von Stahlbrücken" and Fritz's "Verbundträger", written in

traditional engineering style in the 1950's and early 1960's, form a firm basis for the analysis of composite structures. The cover pages of these books are shown in Fig. 2.3. All of them, however, are restricted to steel-concrete composite girders, which of course cover the major part of long-span girder structures common in big structures like bridges.

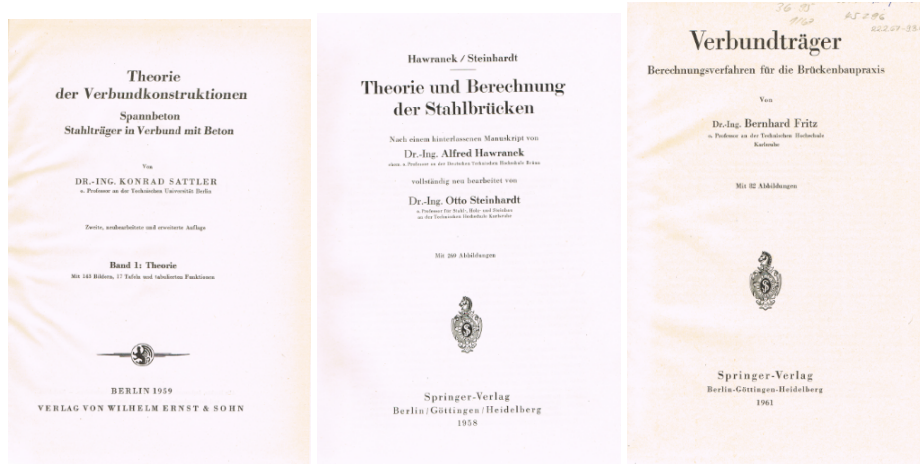


Figure 2.3: Cover pages of the books of Sattler, Hawranek & Steinhardt and Fritz, respectively.

The theory behind, however, can easily be extended to multi-material structures that already exist when, for instance, fibre-based structures are developed in construction process. Such a new and unique theory is presented below.

## 2.2 Mathematical formulation

Let us consider a girder, whose cross-section consists of  $n$  different parts having each its own material properties. Let the axial stiffness and bending stiffness of a general part  $i$  be  $C_i$  and  $D_i$ , respectively. Here  $D_i$ , means bending stiffness with respect to the own principal axis of part  $i$ .

As common, the assumption of Bernoulli-Navier is supposed to be valid. That means that a plane perpendicular to the girder axis, here axis  $x$ , remains as a plane after the deformation of the girder. The consequence of this assumption is clearly shown in Fig. 2.4.

In Fig. 2.4, a longitudinal section of the girder studied is shown. The length of the section is considered to be 1 (number one), The coordinate axis system in a cross-section is chosen so that axis  $y$  is pointing downwards and axis  $z$  is horizontal on the level of the reduced center of gravity axis of the cross-section according to the right hand's rule. Deformations due to shrinkage, creep, temperature changes, axial forces and bending moments around the  $z$ -axis, respectively, are considered. During deformation the vertical line originally at distance 1 from the section's left end is moved to the right and inclined. Consequently, each part of the girder is stretched and inclined accordingly.

The symbols used in Fig. 2.4 are the following:

- $i$ : number of material
- $n$ : total number of different materials in the cross-section

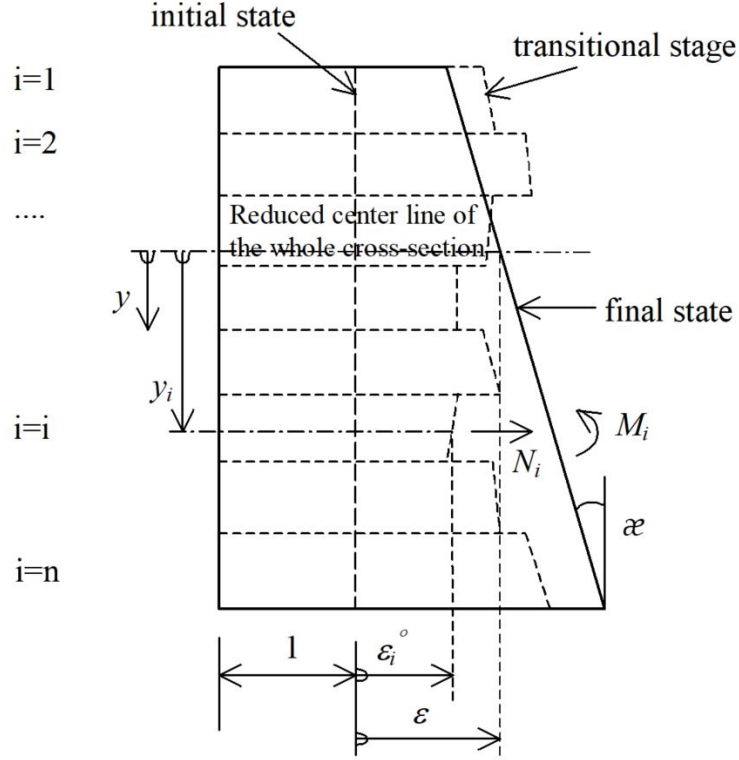


Figure 2.4: Longitudinal section of the girder used to develop the present theory.

- $y$ : coordinate measured from the reduced center of gravity axis of the cross-section
- $y_i$ : coordinate of the center of gravity axis of part  $i$
- $N_i$ : axial force in part  $i$
- $M_i$ : bending moment in part  $i$
- $\varepsilon$ : relative axial elongation at the level of the reduced center of gravity axis relative axial elongation at the level of center of gravity axis of part  $i$  when no composite action exists
- $\kappa$ : curvature of the cross-section due to deformations.

Due to definition of the reduced center of gravity axis

$$\sum C_i y_i = 0 \quad (2.1)$$

where  $C_i$  denotes the axial stiffness of part  $i$  (equal to  $E_i F_i$  in Fritz's formulation). For the whole cross-section

$$C = \sum_{i=1}^n C_i \quad (2.2)$$

and

$$D = \sum_{i=1}^n (C_i y_i^2 + D_i) \quad (2.3)$$

where  $C$  is the axial stiffness and  $D$  is the bending stiffness of the whole cross-section with respect to  $z$ -axis, respectively, and  $D_i$  is the bending stiffness of part  $i$  when bending occurs around its own horizontal center of gravity axis (the corresponding symbols used by Fritz are  $K$  for  $C$  and  $S$  for  $D$ , respectively).

Due to temperature changes, shrinkage or any other similar reason part  $i$  undergoes elongation or curvature so that the free relative elongation is  $\varepsilon_i^\circ$  and the angle of curvature is  $\kappa_i^\circ$ , respectively. To make the cross-section to remain plane (Bernoulli's assumption), in each part  $i$  axial force  $N_i$  and bending moment  $M_i$  are needed. If the final relative elongation on the level of the reduced center of gravity is  $\varepsilon$  and the final curvature is  $\kappa$ , then the constitutive equations related to part  $i$  have to obey the laws

$$N_i = C_i(\varepsilon - \varepsilon_i^\circ + \kappa y_i) \quad (2.4)$$

and

$$M_i = D_i(\kappa - \kappa_i^\circ) \quad (2.5)$$

Because no resulting forces or moments exist,

$$\sum N_i = 0 \quad (2.6)$$

and

$$\sum (N_i y_i + M_i) = 0 \quad (2.7)$$

Considering Eqs. (2.1), (2.2), (2.3), (2.4) and (2.5) it follows from Eqs. (2.6) and (2.7) that

$$\varepsilon = \frac{1}{C} \sum C_i \varepsilon_i^\circ \quad (2.8)$$

and

$$\kappa = \frac{1}{D} \sum (C_i y_i \varepsilon_i^\circ + D_i \kappa_i^\circ) \quad (2.9)$$

Finally, at any point of part  $i$ , the axial stress

$$\sigma_i = E_i [\varepsilon - \varepsilon_i^\circ + \kappa y - \kappa_i^\circ (y - y_i)] \quad (2.10)$$

where  $E_i$  is the modulus of elasticity of the material at the same point.

## 2.3 Special case 1: Shrinkage

Only one part  $r$  is elongated by an amount of  $\varepsilon_r^\circ$ , i.e.  $\varepsilon_i^\circ = 0$ , when  $i \neq r$  and  $\varepsilon_i^\circ = \varepsilon_r^\circ$ , when  $i = r$ . For each value of  $i$   $\kappa_i^\circ = 0$ . Thus, in this case,

$$\varepsilon = \frac{C_r}{C} \varepsilon_r^\circ \quad (2.11)$$

$$\kappa = \frac{C_r y_r}{D} \varepsilon_r^\circ \quad (2.12)$$

$$\sigma_i = \begin{cases} E_i \varepsilon_r^\circ \left( \frac{C_r}{C} + \frac{C_r y_r y}{D} \right) & (i \neq r) \\ E_i \varepsilon_r^\circ \left( \frac{C_r}{C} + \frac{C_r y_r y}{D} - 1 \right) & (i = r) \end{cases} \quad (2.13)$$

In bridge construction a common situation is that a girder consists of four materials at the most, namely concrete, steel, reinforcing steel and prestressing steel. In such structures only



one material, i.e., concrete shrinks, but it causes elongation, curvature and stresses in all parts. These are mainly dependent on the properties of the shrinking material, but also of the stiffness properties of the whole cross-section. Only one formula, respectively, is needed to cover elongation and curvature, but for stresses it is not the case. One formula is needed to cover the stresses in the shrinking part and another one for the other parts, as shown by Eq. (2.13).

When comparing the latter formulation of Eq. (2.13) with the corresponding equation derived by Fritz (Fritz's Eq. (C.14)) one can notice a discrepancy between them. The sign of the second term of Eq. (2.13) is plus, but in Fritz equation it is a minus. According to the present author there is a printing error in Fritz's formulation, which, however, has been corrected later in Eq. (C.92).

## 2.4 Special case 2: Uneven but linear change of temperature

As a second example let us consider a linear vertical change of temperature through the structure. Let us assume that temperature increase on the top level is  $t_0$  and on the bottom level  $t_u$ . The height of the structure is  $h$  and the coefficient of thermal expansion  $\lambda$  is equal in all materials (Fig. 2.5).

Based on the geometry shown in Fig. 2.5, the curvature and elongation values shown in Eqs. (2.14) and (2.15), respectively, are easily derived. Consequently, using Eqs. (2.1), (2.2), (2.3), (2.8) and (2.9), the results shown in Eqs. (2.16) and (2.17), respectively, are obtained. Finally, using Eq. (2.10), the important result shown by Eq. (2.18) is obtained. This means that when the temperature distribution is linear and all materials possess equal coefficient of thermal expansion, no internal forces or stresses are created in an internally and externally statically determinate structure, only deformations.

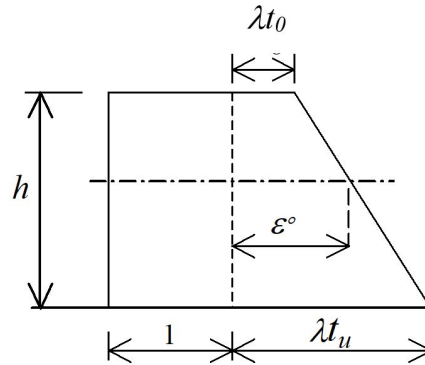


Figure 2.5: Linear change of temperature and the symbols used.

$$\kappa_i^\circ = \frac{\lambda(t_u - t_\sigma)}{h} \quad (2.14)$$

$$\varepsilon_i^\circ = \varepsilon^\circ + \kappa_i^\circ y_i \quad (2.15)$$

$$\varepsilon = \varepsilon^\circ \quad (2.16)$$

$$\kappa = \kappa^\circ \quad (2.17)$$

$$\sigma_i = 0 \quad (2.18)$$

## 2.5 Conclusion

Strictly speaking, the first composite structures were created, when the use of reinforced concrete beams and slabs was started in the late 1800's. Such structures, however, were never considered or analysed as composite structures, and that is still the case today. The next step was two-folded: a concrete deck was cast on steel girders or a steel girder was imbedded into concrete. In the early 1900's such structures were widely used in building and bridge construction, respectively. The interesting thing is that they were never analysed as a composite structure, although the composite action is obvious, as it was realized half a century later. To create a real composite action in girders, different connectors were developed and taken into use. Such connectors, however, were laborious to install and created fatigue problems in steel mainly because of many lateral welds in the upper flange of the steel beam. A considerable improvement was achieved, when simple stud bolts with small welds around the stud shaft and great working efficiency were developed and taken into use in the 1960's. Another problem was the creep of concrete that diminished the efficiency of the composite action as well and caused cracks in the concrete deck slab in the negative moment regions. The method to tackle those problems was to prestress the girder either by lifting it during the casting phase or by using prestressing tendons. Consequently, a girder with four different materials was created, and the theoretical studies and practical analysing methods, developed by Sattler, Hawranek, Steinhart, Fritz and others, could be utilized. Later, in the 1990's, also other types of composite structures were developed, for instance wood-concrete composite girders. The same theoretical analysing methods are valid for them, too. The present author was strongly involved with that developing work and found it useful to extend the theory of composite structure analysis to cover all kinds of materials. Consequently, the generalized theory for shrinkage and change of temperature analysis of composite cross-sections presented above, was developed. At the same time, it was worth of modifying the relatively complicated notations used by the earlier researchers. By this way it is hoped that the understanding of the theory itself becomes clearer as well. Finally, as seen from Eqs. (2.8), (2.9) and (2.10), only three simple equations are needed to cover all possible cases for the analysis of a composite girder consisting of any amount of different materials and different types of cross-sections.

## 2.6 Acknowledgements

The paper is devoted to two of the author's good Hungarian friends and colleagues, Professors Dr Géza Tassi, and Dr Miklós Iványi, who always supported and encouraged the author in professional and private life endeavours. That would certainly be the case now as well, if they were aware of this paper.

Furthermore, the author's sincere thanks also go to Professor Dr György L. Balázs and the author's former Ph.D. student, emeritus Associate Professor, Dr Tech. Bertalan Szabó, both from the BME, for their encouragement and assistance during the writing process of the paper.



## Tribute 3



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Abstract book for the

19th Miklós Iványi International PhD & DLA Symposium

Péter IVÁNYI (Editor),

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# Integrating Experimental Studies in Structural Steel Research and Education

**Jenő Balogh**

*Department of Engineering, Metropolitan State University of Denver, USA*

**Keywords:** experimental investigations, steel design education

## Abstract

Prof. Dr. Miklós Iványi has made profound contributions to modern structural steel engineering research and education in Hungary as well as internationally. The author had the privilege to be his doctoral student, colleague, and friend, while working with him for two decades. This paper presents the significance of experimental investigations in steel research and education through Dr. Iványi's achievements and is dedicated to his memory. During his career spanning 50 years, Dr. Iványi was instrumental in building strong, internationally integrated educational programs at two Hungarian universities and achieved world-wide recognition. He instilled in his students the appreciation for experimental investigations, which is fundamental to understanding material and structural behavior, and is indispensable to the development of improved computational models that modern steel design increasingly relies on.

## 3.1 Introduction

Dr. Miklós Iványi's overarching scientific work can be best characterized by synthesizing subject areas of plasticity, stability, and structural design theories, even though he also achieved significant results in every one of these areas individually. Building on the legacy of his professor, Dr. Ottó Halász, he established world class steel design education and research programs at Technical University of Budapest (BME). During his 40 years tenure at BME, Dr. Iványi served as professor, department head, and vice-rector, as well as head of the research group of the Hungarian Academy of Sciences at BME. He spent the last ten years of his career at University of Pécs, where he had a key role in establishing the BSc program at the Faculty of Engineering and Information Technology, and served as one of the heads of the Marcel Breuer Doctoral School.

The numerous research projects Dr. Iványi conducted at BME, most with a substantial experimental component, led to international research cooperations, creating unique opportunities for his graduate students.

## 3.2 Research programs

Dr. Iványi's major area of research was on the stability and ductility of steel frames and steel plated structures with stiffeners. The Hungarian Scientific Research Fund (OTKA) and various international programs (e.g., TEMPUS, COST) sponsored several research projects in

this subject area. The ductility of the structure enables prediction of the ultimate capacity of a structure, which is the most important criteria in the design of structures. Initial research focused on the development of ductile details for steel construction and rigorous requirements were enacted to make stability-related failures as ductile as possible or to avoid them all together. Material, member, and structural (such as with semi-rigid connections) ductility is required in the design for ductile response. Therefore, eventually, the research concentrated on how the load-displacement curves of steel frames can be constructed as exactly as possible with the ductility, or how the limit load can be, using approximate methods, estimated with the softening phenomenon. An example [1] for a simple structure is described in Fig. 3.1. Presently, continuing in the same direction, more advanced methods for damage modeling are developed.

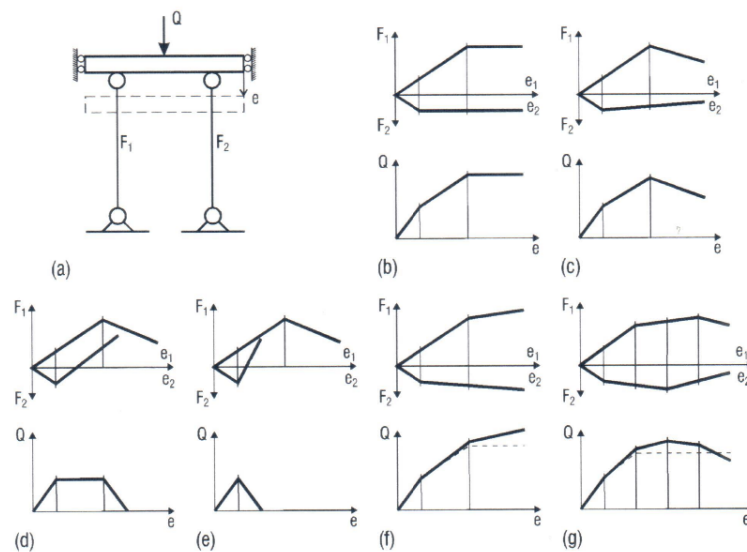


Figure 3.1: Behavior of a simple structure

Dr. Iványi suggested early on a procedure that takes into account the softening character of the inelastic hinge in the form of an interactive zone [2], see Fig. 3.2, in which the softening is caused by the buckling of the component plates and can be studied through the yield mechanism.

A unique device available at the structural testing laboratory of BME, that Dr. Iványi cherished, was a gravity load simulator [2, 3], that enabled testing of sway frames under simultaneous lateral and vertical loading with minimal load-structure interaction (Fig. 3.3).

### 3.3 Educational programs

The extensive theoretical and experimental work conducted in the laboratory of BME resulted in 40 scientific books and more than 220 scientific papers. The author assisted Dr. Iványi with the digitization and creation of multimedia editions of some of his publications, such as the Structural Stability textbook, which was used in the distance learning program at BME, and the Refurbishment multimedia CD, which is used as a reference material in the Refurbishment of Structures course at Metropolitan State University of Denver (MSU Denver), see Fig. 3.4.

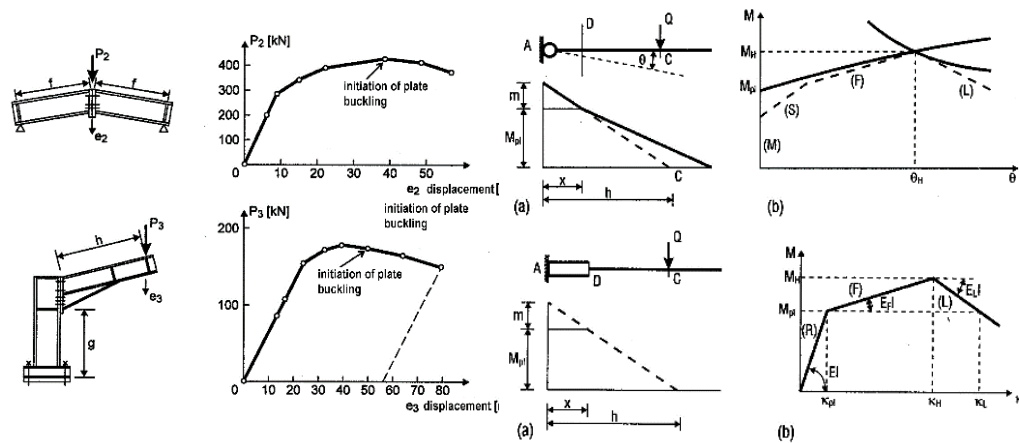


Figure 3.2: Experimental study of steel frame joints (left) and proposed models (right)

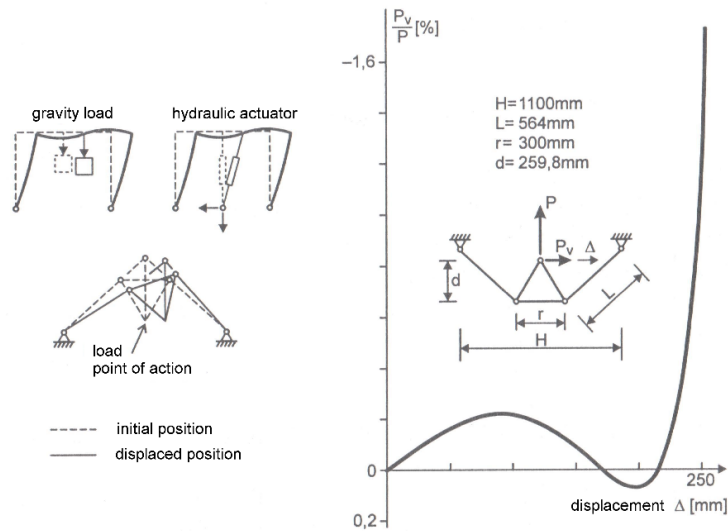


Figure 3.3: Gravity load simulator and its behavior

Dr. Iványi's unequivocal love of bridges is well reflected by the CD-based catalog of the Danube bridges he edited, shown in Fig. 4. This was also evident during our joint travels within the United States on our way to the North American Steel Construction Conferences (NASCC), when we had the opportunity to visit bridges such as the Tacoma Narrows Bridge, WA, the world's highest, the Royal Gorge Bridge, CO, and maybe the most iconic, the Golden Gate Bridge, CA, shown on Fig. 3.5, 3.6, and 3.7, respectively.

It was always a great pleasure traveling with Amália and Miklós Iványi. His international stature was clearly recognized by the profession everywhere in the US. Besides being involved with national and international professional organizations and several top international journals, Dr. Iványi was the main organizer or member of the advisory board of more than 30 international conferences. One particularly memorable conference, organized by the Structural Stability Research Council (SSRC), where Dr. Iványi was the Chairman of the International



Figure 3.4: Structural Stability textbook (left), Refurbishment CD (top-right), and Bridges on the Danube catalog CD (bottom-right)



Figure 3.5: At the Tacoma Narrows Bridge, WA, 2002

Cooperations Task Force, and the American Institute for Steel Construction (AISC), was held in Seattle, WA, in 2002, see Fig. 3.8.



Figure 3.6: At the Royal Gorge Bridge, CO, with Dr. Z. Balogh and Dr. A. Iványi



Figure 3.7: At the Golden Gate Bridge, San Francisco, CA, 2004

## Acknowledgements

Dr. Miklós Iványi was instrumental in establishing the framework of the institutional cooperation between the author's institution, MSU Denver, and University of Pécs.





Figure 3.8: NASCC reception at the Boeing Museum of Flight, CA, 2002 with Dr. Z. Balogh, Dr. A. Iványi, and Dr. T. Galambos

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## Tribute 4



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# Professor Miklós Iványi: An Appreciation

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*Honorary Professor University of Pécs, Hungary*

In 1978, after completing a PhD in London, I was appointed Lecturer in Civil Engineering at Edinburgh University. It was shortly after my arrival in Edinburgh that I became aware of the engineering research activity in Hungary. It was apparent that there was one renowned researcher in Hungary, with a world class reputation, and that was Professor Miklós Iványi, whose research field did have some potential links with that of my own. I had an interest in structural optimization and steel structures provided a perfect research area. On leaving Edinburgh University to take a post at Heriot-Watt University (Edinburgh) in 1988, I resolved to try and make contact with Professor Iványi. In November 1989, the Berlin Wall came down and a period of “change” occurred. Before I could contact Miklós, I received a letter from a Hungarian student asking if he could complete his Diploma project with me in Edinburgh. He was to be funded as a “free mover” by the European Commission and stay for six months. More interestingly, he was also “a student of Professor Miklós Iványi”.

The student, Janos Sziveri, spent eight months working on a project concerned with computer programming and structural analysis. During his stay he spoke fondly of his professor and described how Miklós had lectured during his final year on the structural analysis of the Holy Crown of Hungary. I wondered if he had done so before the period of “change” occurred. I was further intrigued by this and Janos’ obvious enthusiasm. So, after Janos returned to Hungary, at long last, I made a visit, funded by The British Council, to meet this “Hungarian Professor who had an international reputation” in the days before the “change” and long before Hungary joined the European Union.

The first meeting with Miklós, held in his office overlooking the Danube in Budapest, was relevant to my interests in MSc Courses and PhD research in structural engineering computing. On my return to Edinburgh I successfully applied for funding for Janos Sziveri to undertake his PhD in Edinburgh. Then Miklós sent his son, Peter, for two summer research visits. At the time, the main focus of my research group was on the use of multiple processors for the analysis and design of structures. The early processors were difficult to programme with inter-processor communication only possible using four simple serial links for each processor; but Peter and Janos managed to get the processors to work. Janos stayed with my research group for six years and Peter for seven years. Other students and staff visited from Miklós’ department at various times.

Academic performance is usually on a very personal basis with academics competing for funding, students and staff. By contrast, Miklós was very generous and altruistic; his personal support and encouragement was extremely important to me and my research group. It was clear to me that he saw computing or information technology as the future. I was a regular visitor to attend meetings that Miklós organised in Budapest. In 2000 Miklós and I edited a volume of Conference papers concerned with computational steel structures. As usual, it was a great pleasure to work with him.

In 2004 Miklós moved from Budapest to Pécs, following his wife, Professor Amália Ivanyi, who had moved to Pécs in 2003. In particular, I remember an early visit and a long discussion with Miklós and Professor János Bársony to discuss engineering education in PhD studies. I attended the first PhD Symposium, a series which he established in 2005, and have been visiting the Faculty every year now for over twenty years. At the third PhD Symposium, Miklós proposed that I should be made Honorary Professor in the Faculty. Then in 2011, I was awarded an Honorary DSc and made an Honorary Professor by the University. So personally, I owe Miklós a great debt.

In 2006, Miklós established, with Professor Amália Ivanyi, the International Journal for Engineering and Information Sciences, Pollack Periodica. This complemented the PhD Symposia perfectly. He greatly improved the environment and infrastructure for PhD research in Pécs. So, we all owe him a great debt. Sadly, we lost an outstanding teacher and researcher in 2013. I lost a mentor and a great friend who had shown me such kindness and supported me in many ways that enhanced and enriched my life and career. I think those who had experience of Miklós Ivanyi, in their professional life, will remember him as enthusiastic, hardworking, kind and generous. So, it is important and right that we continue to remember and salute him by continuing to name the Pécs PhD Symposium after him. In doing so, we continue to recognise all that he did for engineering education and research both in Hungary and internationally.





# **Architecture**





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## Paper 1

# Enriching Architectural Education with Extracurricular Activities - the Case of the Geometry Adventure Workshop

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**Keywords:** Grasshopper, workshop, geometric models

In this study, we present and analyse the case of the Workshop titled “A Geometric Adventure in the World of Grasshopper”, realised in September 2023, at the University of Belgrade, Faculty of Architecture, within the manifestation called “The Week with Architecture”. The content of the Workshop has been derived from the elective course “Parametric Modelling”, offered to the first year master students.

After briefly explaining the teaching context in which the Workshop occurred, we present the content structure divided into four working days, three of which dedicated to introducing various programming techniques in the Rhino software and its well-known plug-in Grasshopper, and the fourth day left for the Workshop exhibition completing. Aimed at introducing programming beginners into basic techniques of algorithmic creation of architectural form, this Workshop started with an in-house developed Grasshopper definition producing various 2D geometric patterns. Based on this simple definition the students learned the fundamental elements of the visual algorithmic systems. As a result of first day they produced a range of different geometric patterns based on the p1 symmetry repetition of circles and polygons on a predefined rectangular grid. The second day of the Workshop was dedicated to the geometry of spatial curves, and required from the participating students considerably more programming understanding and an additional research of the field. The third Workshop day was characterized by an integration of the techniques of the first and the second Workshop day. In this final programming exercise the participants had to use the geometric grid, in terms of distribution of a chosen spatial curve.

This teaching activity resulted in excellent geometric models created by participating students, exhibited in the form of prints, the last day of the Workshop. All the Workshop communication and information exchange was supported and saved in the specially created TEAMS learning environment. A catalogue of student submissions is in the process of creation. The Workshop influenced the teaching of the Elective course “Parametric modelling” in terms of introducing new topics and rearranging selected teaching activities.

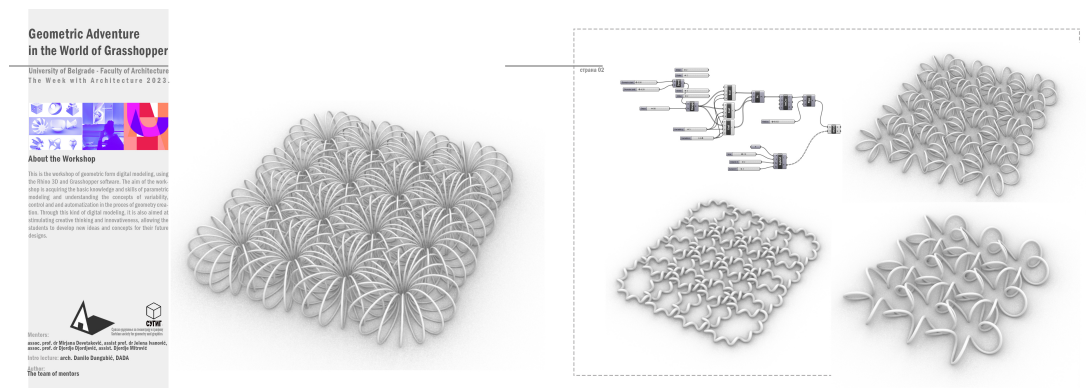


Figure 1.1: A Geometric Adventure in the World of Grasshopper – Teachers' preparations



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## Paper 2

# Wooden Structures Used As Primary Construction Materials with Optimized Building Designs for Low Carbon Footprint and Long Building Lifetime

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*Marcel Breuer Doctoral School of Architecture, University of Pécs, Hungary*

**Keywords:** wood, architecture, sustainability, innovative design, engineered timber

New, large scale timber buildings are being built more often around the world in the last decade. Timber and engineered wood can substitute or even replace steel and concrete structures in construction projects. When combined with smart engineering, creative design and clever space usage, it can extend a building's lifespan and reduce its carbon footprint. This paper is looking at the global environmental impact of steel and concrete, and what are the limits of wooden architecture in replacing it, as well as demonstrating what sustainable future for architecture looks like, and what part wooden structures and construction are going to play in it. Examples of multiuse, creative, modular and innovative buildings from engineered timber, compared to traditional building materials will be examined. How can well designed wooden buildings create a comfortable, contemporary built environment? Can wooden buildings replace traditional building methods and fulfill 21st century expectations?



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## Paper 3

# The Practice of Mortise and Tenon Construction in the Basic Lesson of Architectural/furniture Design

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**Keywords:** mortise and tenon jointing, traditional techniques, bucket arch, traditional wisdom

Mortise and tenon joints are one of the construction techniques traditionally used in ancient Chinese architecture, as well as other wooden structures, furniture and musical instruments. Over the past thousands of years, mortise and tenon construction has undergone a process of continuous exploration and innovative development, branching out into more than a hundred different styles. Some of the world's largest preserved wooden buildings - the Hall of the Holy Mother of God at the Jin Temple in Shanxi, built before the Northern Wei Dynasty, and the Forbidden City Palace in Beijing - have become World Heritage Sites, and continue to be used even to this day.

Mechanical principles are deeply embedded in the delicate structure of mortise and tenon joints. The protruding tenon and recessed mortise and tenon eye are joined together by a concave-convex fastening. To make sure the joint does not become loose over long-term thermal expansion and contraction of the wood, craftsmen apply this joint structure using the mortise and tenon from different angles and orientations, ensuring that the energy from thermal expansion and contraction is cancelled out.

There has been renewed interest in the study of mortise and tenon structures and how they can be applied to new design principles and values. An example is how the traditional mortise and tenon structure can be improved through scientific study, standardisation or made more modular. One purpose is to adapt it to meet the modern "urban nomadic" way of life, to create mortise and tenon structures in the application of modern home design. The main focus of this research is towards teaching practice, so that the traditional construction wisdom can be handed down and adapted to modern design, providing the new construction culture with a valuable heritage.

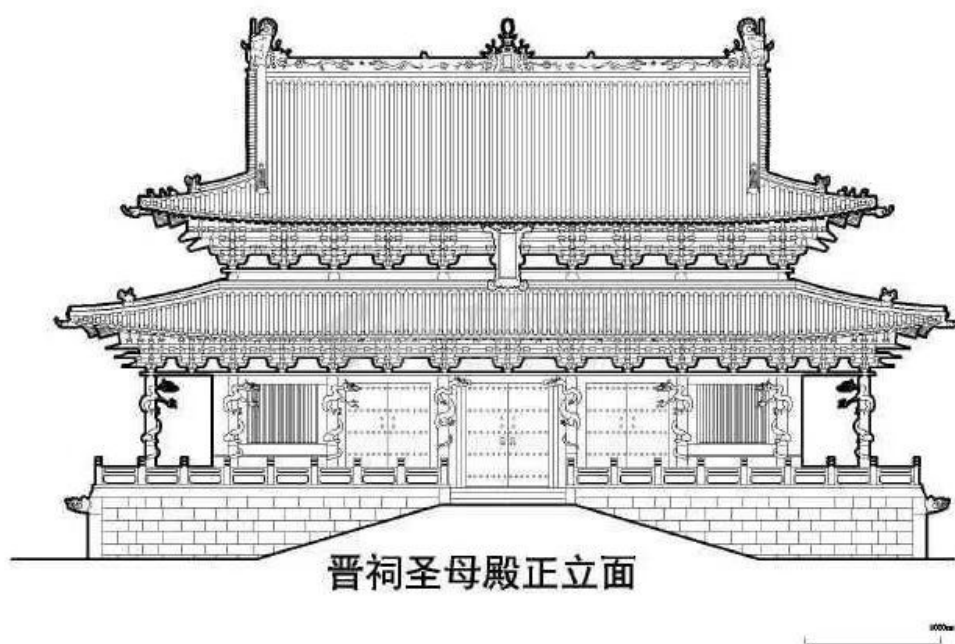


Figure 3.1: Elevation of the Hall of the Mother of God at the Jin Temple in Shanxi before the Northern Wei Dynasty





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## Paper 4

# One Step Closer to Sustainability: 3D Printing Technology in Architecture Using Recycled Solid Waste As Raw Material

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**Keywords:** concrete 3D printing, solid waste, recycle architecture, 3R method, sustainable design

With the continuous development of society, large industrial solid wastes are dumped in large quantities, widely distributed, causing far-reaching harm to the environment, recycling has become an indispensable part of environmental protection. Concrete 3D printing technology has become one of the intelligent construction development directions in the construction industry, and the application prospect of directly printing out the building is getting increasingly broad. The advantages of efficiency, intelligence, and precision offered by concrete 3D printing can make it possible to simplify the building process, and reduce resource consumption and low-load on the environment. The use of industrial solid waste to prepare environmentally friendly concrete 3D printing materials and their use in building design is one of the feasible methods of utilization at scale, and these results provide not only a sustainable pattern for 3D printing building materials and development but also an innovative strategy for the proper exploitation of industrial solid waste.

This project focuses on the practical application research of using 3D printed concrete raw materials made from solid waste recycling to achieve RECOVER, RECYCLE, RECYCLE (3R) in the field of building construction. It also focuses on the analysis of the characteristics and advantages of using recycled materials in the architectural design and construction made by 3D printed concrete; explores the extensibility of the 3D printed concrete technology, with an emphasis on the collection, emphasizing the possibility and convenience of collecting, utilizing the surrounding waste materials to give a new look to the abandoned buildings on the original basis. The main problems faced by the development of 3D printed concrete technology in terms of scenario planning, architectural design, materials, and equipment are summarized and finally, the future perspectives of 3D printed recycle concrete in the context of sustainable construction is envisaged.



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## Paper 5

# Energy Efficiency and Viability of 3D Printing Technology in Concrete Construction

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**Keywords:** energy efficiency, 3D printing concrete, energy simulation

The construction industry is a major contributor to climate change, accounting for approximately 38% of global energy-related carbon dioxide emissions. 3D printing is a rapidly developing technology that has the potential to revolutionize the construction industry by allowing complex building components to be created with less material waste and energy consumption than traditional construction methods. Furthermore, 3D-printed buildings can be made more energy-efficient by including features such as improved insulation and air sealing. The research focuses primarily on the energy efficiency and viability of 3D-printed concrete houses. The simulation study will compare the energy performance of traditionally built and 3D-printed houses using the building energy simulation software IDA-ICE. The simulation will consider various factors, including the building envelope, and climate type. The simulation study is based on a referential model. It does not encompass the full spectrum of real-world variability. However, the research findings and conclusions may not be universally applicable to all regions, construction contexts, or building types. Variations in local regulations, climate conditions, and architectural designs may have an impact on the results' generalizability.



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## Paper 6

# Study on Ageing Renewal Strategies for Public Spaces in Older Communities

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**Keywords:** semantic analysis method, older communities, ageing, renewal strategies, Wuhan city

With the rapid development of urban construction and the deepening of population ageing in China, older communities demonstrated the characterized by their large number of quantity and small size of volume. As the main area for the life and activities of Chinese older people, communities play a key role in promoting the physical and mental health of older people as well as neighborhood relations. As the needs of the elderly continue to increase at both the material and spiritual levels, the ageing renewal of old communities has become a major goal of urban construction in China. Starting from the design concept of "human-oriented", in order to better grasp the various needs of old communities for living environment, this paper takes three typical old communities in Wuhan as the objectives, and summaries the types of behavioral activities of older people and the characteristic patterns of their spatial distribution. Interview questionnaires were administered to 250 elderly people, and semantic analysis was used to quantify the psychological impact of the community environment on the residents, and to propose ageing enhancement strategies based on the psychological and behavioral needs of the elderly.



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## Paper 7

# “Signal Envelope”: Urban Interface and Public Space Design Strategies Based on Millimeter-Wave Adaptation

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**Keywords:** urban public space, 5G millimeter wave, new factor, signal envelope, design strategy

Global urbanization involves the dynamic interplay between infrastructure and urban dynamics. In the 21st century, 5G drives new infrastructure for IoT and smart cities. Yet, millimeter-wave limitations affect coverage. This paper addresses the contradiction between urban public spaces and 5G.

Current research emphasizes 5G's demands on urban spaces but neglects millimeter-wave adaptability. The oversight has raised costs and inefficiencies. This study explores the relationship between urban spaces, interfaces, and millimeter-wave channels. Grasshopper is used for quantitative analysis of spatial forms and millimeter-wave LOS scenarios. Key parameters, such as floor area ratio, building density, and height, impact millimeter-wave adaptability.

We introduce a “signal envelope” design theory for on-demand millimeter-wave adaptive urban spaces, aligning urban design with millimeter-wave coverage. At a macro-level, we discuss integrating the “signal envelope” into urban planning to enhance millimeter-wave adaptability, promoting architecture, urban design, and 5G for IoT cities.



Figure 7.1: Conceptual Model of a Commercial Street Generated Based on the 'Signal Envelope'



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## Paper 8

# Co-design and Service Design for Sustainable Nature-Based Solutions Implementation

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**Keywords:** nature-based solutions, co-design, service design, monitoring and evaluation

Nature-based solutions (NBS) are gaining attention in the Horizon 2020 (H2020) framework due to their potential to address environmental and societal challenges. Co-design methodologies are emerging as a promising approach to engage stakeholders in NBS projects. This paper examines the role of co-design approaches in H2020 NBS projects and how Service Design can contribute to their success.

While NBS projects have made progress in enhancing urban ecosystems, concerns persist regarding maintenance, stakeholder engagement, and effectiveness. This study investigates the use of co-design methodologies in H2020 NBS projects, with a focus on stakeholder engagement. Local communities, experts, and policymakers are frequently involved in these projects. Specifically, this research explores Service Design as a framework for understanding user needs and improving the user experience of NBS interventions.

Co-design methodologies, particularly Service Design, show promise in shaping the future of NBS projects within H2020. By involving stakeholders and prioritizing sustainability, these methodologies can support the maintenance of NBS interventions. The study recommends incorporating successful practices from Service Design and other co-design methods into future monitoring and evaluation frameworks for NBS projects.



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## Paper 9

# The Impact of Collaborative Design on Rural Sustainable Development in Hungary

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**Keywords:** sustainable development, rural development, economic development, collaborative design, SRoI analysis, traditional craft technologies, market interests

Sustainable rural economic development is a frequently discussed topic where there is no consensus on how exactly to measure and define the factors and dimensions. The objective of this study is to define the components of economic development and their relations in the Hungarian rural context. The research included the analysis of environmental, socio-economic data related to the South Transdanubian Ormánság region. Based on the data obtained, a collaborative, long-term pilot case study for economic development was carried out, involving a product development based on traditional craft technologies and contemporary design. The testing phase examined an SRoI (Social Return on Investment) analysis, the relationship between the collaborative design participants, market interest, and levels of sustainability and design education.



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## Paper 10

# Adaptive Design of University-built Libraries in the Digital Age

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**Keywords:** adaptive design, built libraries, spatial transformation, site analysis, intervention design

With the advent of the AIGC era, digital reading and learning have become ubiquitous. The library remains the foremost education and communication space in higher education institutions, but libraries built over ten years ago are confronting a multitude of challenges that impede effective modern teaching and learning. This paper analyzes the built environment and intervention design methodology using relevant concepts and theoretical frameworks. The study employs the adaptive design method and utilizes the library of Shandong University of Arts as a case study to investigate the environmental space design of physical libraries in the context of the data era. It examines the beneficial impacts of adaptive design on the spatial transformation of physical libraries, enabling them to adapt to the digital future.





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## Paper 11

# The Application of Emotional Design in Lighting for Healthcare Spaces

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*Faculty of Engineering and Information Technology, University of Pécs, Hungary*

**Keywords:** healthcare spaces, indoor lighting, emotional design

With the wide application of design psychology in interior design, it makes people have more physiological and emotional needs for a comfortable interior space. Interior lighting design is an extremely important part of interior design, especially in the medical field. In order to meet the needs of the majority of Chinese patients and health care workers for medical space lighting, design more suitable for the audience groups to live and work in the indoor environment, the creation of indoor lighting in the medical space should break through the limitations of the basic functional requirements, in line with China's lighting requirements for the functional areas of the hospital at the same time, emphasize the positive impact of light on the audience groups of spiritual and health emotional design, the formation of rehabilitation and treatment-oriented lighting design. Therapy orientated lighting design. In addition to the above conditions, energy costs will be saved through careful design of the lighting scheme. Taking the application of emotional design concepts in design psychology in medical space lighting design as an entry point, we focus on analyzing the psychological impact of light intensity, colour temperature and warmth in the lighting layout, as well as the application of different materials in the design of lamps and lanterns on the audience, and discussing the ways of integrating emotional design concepts into medical space lighting design by combining with the current status of medical space indoor lighting problems and relevant cases. It also discusses the ways to incorporate emotional design concepts in medical space lighting design by combining the current problems and relevant cases.

### CHINESE HOSPITAL BUILDING LIGHTING STANDARD VALUES

Area	Illumination standard (lx)	Colour rendition (Ra)
Ward	50-100	80
First aid ward	500-1000	80
Operation room (general)	1000	90
Operation room (working table)	20,000- 40,000	90
Operating room (x-ray ward)	0-100	80
Maternity ward (delivery bed)	5000-10000	90
Maternity ward (delivery area)	250-500	80
Exam room	200-500	90
ICU (around beds)	100-200	90
ICU (checking area)	500-1000	90
Corridor	100-200	80
Waiting room	200	80
Office(general)	300	80
Office (examination)	1000	90

Figure 11.1: Chinese hospital building lighting standard values



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## Paper 12

# Design of Light Environment in Art Museums Based on Quantification of Emotion

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**Keywords:** light environment, emotion quantification, art museum, spatial design

Light is an important factor for the atmosphere and feeling of space, and light will have a certain influence on human emotions through visual perception. The visual expression of light in the exhibition space is especially important, and its spatial design should not only pay attention to the aesthetic value, but also pay attention to the emotional value of the space for users. This paper focuses on the art museum space as the carrier, and quantifies and analyzes the emotional changes caused by light in the art museum space through the research methods of literature theory combing, practical research, data collection, and PAD emotion quantification model. It aims to explore the scientific application framework of emotion quantification in the light environment design of art museum, and to provide reference value for the research of visual experience and emotion in exhibition space.



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## Paper 13

# Architectural Reconstruction and Presentation of the Peristyl House of Aquincum through Augmented Reality

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**Keywords:** roman architecture, history of architecture, Aquincum, reconstruction, virtual reality

The built heritage is an important reflection of our communities' spirit. The complex layers of architectural history weave through our entire built environment like a web. In more fortunate places, the condition of historic buildings allows people to physically experience this heritage. In less fortunate places, the ravages of time often only reveal the built past in foundations and structural fragments. However, due to a lack of appropriate architectural and geometrical knowledge, most people are unable to perceive real spatial relationships from these fragments and therefore cannot meet a true spatial experience. By the 2020s, the development of entertainment technology and computer graphics game engines had advanced to the point where architectural reconstructions could not only be presented in print and on screen, but could also provide people with a real spatial experience of visiting archaeological sites using everyday tools. In my presentation, I will present the theoretical reconstruction and 3D representation of the so called Peristyl house studied in Aquincum, addressing the issues of uncertainty due to fragmented data, reconstruction based on analogies, modeling and model optimization, virtual reality (VR), and augmented reality (AR).



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## Paper 14

# Modular Design of Teaching Interior Space

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**Keywords:** teaching space, interior space, smart classroom, modular design, sustainability

With the advent of the educational information age, the development of teaching space is facing new forms. Classroom space, as the main teaching space of the campus, bears more functional needs, and the traditional single teaching function can no longer meet the needs of teachers and students. Modular Teaching Interior Space Design is based on the new needs of the intelligent classroom, to meet the teaching space's multi-purpose, open, functional transformation, and intelligent development. Modular interior building components can be custom designed according to the project's specific needs to accommodate different functional and spatial requirements. The characteristics of the modular design allow the teaching space to be adjusted and expanded according to needs, providing users with more flexible ways of use. Modular design, and modular component assembly type installation, contribute to sustainable development. It can reduce the production of construction waste and improve the effective utilization of materials. The sustainability and ease of disassembly of module components also help reduce resource consumption and environmental impact. In general, the modular teaching space design, and indoor assembly installation is an efficient, high-quality, flexible, and sustainable construction method. In the field of education, it can provide rapid construction, custom design, and adaptive teaching space solutions.



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## Paper 15

# Interior Designs with Architectural Design Thinking

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**Keywords:** architectural thinking, interior design, function

How does architectural thinking make a difference in interior space? Is it just a formal difference? From two-dimensional decoration to three-dimensional space experience, this should be the biggest difference between the two. In simple terms, interior design pays more attention to decoration, while architectural design is basically functional design. If architectural thinking is applied to interior design, will it make the interior space more applicable, more scientific and more infinite? This paper combines a project of integrated architecture and interior design to interpret the infinite possibilities of architectural thinking in interior design. Several types and paradigms of architectural thinking in interior design are summarized.



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## Paper 16

# The Biomimicry Approach for Enhancing Energy Efficiency in Office Buildings in Iraq

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**Keywords:** biomimicry, energy efficiency, energy consumption, global warming, carbon dioxide emissions, sustainability

Energy consumption is a primary concern in contemporary times, with significant implications for global warming and increased carbon dioxide emissions. Biomimicry, a groundbreaking approach, incorporates elements from the natural world into architectural design. Applying biomimicry in architecture offers a fresh and innovative solution for effective cooling in office buildings in Iraq. In recent years, the country has witnessed a rapid surge in the construction of office buildings, often plagued by inefficient construction practices, resulting in excessive energy consumption and significant costs associated with maintaining indoor thermal comfort. Utilizing IDA ICE simulation software to assess energy consumption, it becomes evident that optimizing shading plays a pivotal role in reducing energy demands. Skin adaptation is an innovative technique designed to respond to microclimate changes and reduce energy demand by up to 40% in Iraq. This approach enhances energy efficiency and promotes sustainability, making it a promising avenue for addressing the pressing issue of energy consumption in office buildings in Iraq.



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## Paper 17

# GRID System and Its Flexibility - Considering the Practical Implementation of the Grid System Design Method and Modular Structures in Office Buildings to Enhance Adaptability and Flexibility

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**Keywords:** adaptability, modularity, flexibility, sustainability, offices, grid systems

In the ever-changing realm of the contemporary workplace, adaptability and flexibility have emerged as crucial attributes for office buildings. The method of grid system design, in conjunction with modular structures, fosters a workspace that can seamlessly adapt to the evolving needs of businesses and their employees. The grid system embodies a comprehensive approach to office design, emphasizing the integration of four important principles: modularity, adaptability, interconnectedness, and flexibility. When applied to the design of office buildings, this system enables a built environment that is not only nimble but also sustainable and modular. Structures play a pivotal role in achieving this objective. The system serves as adaptable building blocks that can be effortlessly reconfigured to accommodate various office layouts, departmental expansions, or entirely new purposes, thereby rendering office buildings to highly responsive to shifting requirements. The modular nature of the grid design allows for swift and cost-effective adjustments, facilitating offices to scale up or down as necessitated. This adaptability is particularly valuable in addressing the burgeoning demand for hybrid work models and different-plan layouts that foster collaboration, concentration, and well-being. Furthermore, it encourages flexible connectivity within the office environment, facilitating the integration of technology, smart building systems, and seamless connections. The dynamism of this system ensures that office spaces are in a perpetual state of evolution, reflecting the changing dynamics of the contemporary workplace. This adaptability fosters and represents a forward-thinking approach to create a responsive and future-proof office building environment that aligns with the evolving demands of businesses and their workforce in addition to the ever-changing world needs. Further finds related to the filed are to be found and worked on to advance more in the field of sustainable adaptability in office buildings.



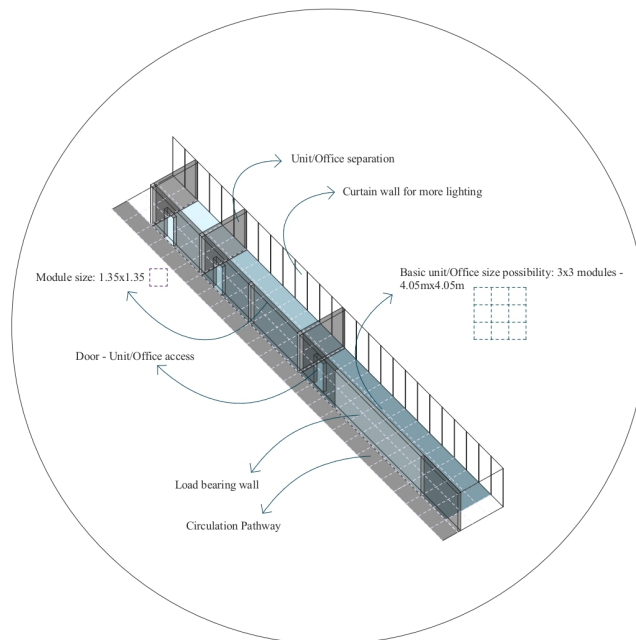


Figure 17.1: Illustration Example of a Grid System in an office, 2023, source: Author



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## Paper 18

# A Renewal Design in an Office Space under the Concept of Sharing

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**Keywords:** sharing space, social needs, office space, renewal design

The office social need is the common need of the new generation, and have attracted more and more attention in recent years. The paper elaborates on a renewal design of office space in “A” Company in Wuhan, discussing the possibility of integrating shared social space into the old office building, summarizes the design principles and strategies of sharing office space based on social needs, starting from the aspects of space layout, space moving line, selection of decorative materials, color matching, interior furnishing scheme. The design try to create a series of shared spaces in an old office building conducive to social interaction, to build an office environment that promotes social interaction for the staff of “A” company and enhances the sense of working experience.



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## Paper 19

# Research on the Optimization Strategy of School Path Space under the Guidance of Child-Friendly Concept and Behavior Pattern

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**Keywords:** child-friendly philosophy, behavior pattern, school path space, optimization strategy

In recent years, the concept of child-friendly cities has been widely valued, and countries all over the world have actively carried out the construction of child-friendly cities. China is entering a society with fewer children, but the construction of child-friendly cities is still in the early stage. Urban road space is usually designed from the perspective of adults, and the needs and safety of children are not considered, so there are few Spaces suitable for children's activities. School space is an important space connecting home and school in children's daily life, and it is also the main space for communication and activities. Its spatial quality is one of the important factors affecting children's character, intelligence and even happiness. In this paper, a variety of research methods, such as observation method and behavior note method, were used to investigate, and evaluate the access space of primary schools in Nanhu District of Wuhan City, analyze the correlation between children's behavior and space environment, and clarify the impact of space environment quality on children's behavior patterns. Through the semantic analysis method, the spatial evaluation of traffic safety, service facilities, space availability and other aspects is quantified, and the factors that children have a higher impact on environmental quality are obtained, to put forward the optimization strategy of general school space suitable for children.



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## Paper 20

# Enhancing Educational Environments: A Systematic Literature Review of Indoor Environmental Quality in Classroom Settings

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**Keywords:** critical review, indoor environmental quality, educational facility, classroom, energy demand

This systematic literature review critically assesses the diverse facets of indoor environmental quality (IEQ) within the context of educational classrooms. Acknowledging the significant impact of the classroom environment on students' learning experiences and overall well-being, this comprehensive study delves into the multifaceted components of IEQ and their influence on cognitive performance, health, and overall academic success.

The primary aim of this research is to offer a systematic review of the current state of knowledge regarding: 1) the fundamental elements of IEQ, including air quality (AQ), visual comfort (VC), thermal comfort (TC), acoustics, air velocity (AV), and retrofitting; 2) the countries with the most analyzed indoor environmental quality; 3) the determination of whether buildings in temperate climate zones are comfortable and the local factors contributing to this effect.

This paper examines all relevant literature on IEQ and related parameters in educational facilities, encompassing teaching environments from kindergarten to university level, spanning the last 23 years ago around world. The paper discusses different factors influencing IEQ, energy consumption, and occupants' well-being. Its primary contribution lies in presenting a synthesis of existing research, identifying knowledge gaps, outlining associated challenges, doctoral research opportunities, and offering future recommendations. Following an extensive electronic database search, 3,429 papers were initially identified. For the current stage of the review, 245 papers were selected for a detailed examination, while 3,184 papers were excluded for various reasons, which are elaborated upon in the body of the paper. This study is intended to provide valuable insights for designers, engineers, and researchers engaged in forthcoming research endeavors.



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## Paper 21

# Health, Relationship, Empathy - A Practical Study on the Construction of Positive Preschool Education Space

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**Keywords:** environmental psychology, children's behavior, space construction, environmental empathy

In the public eye, early childhood education is a significant stage of human life education, which has important significance. Early childhood education has fair-sized flexibility, and all kinds of game activities are the core of early childhood education. Its daily teaching activities are mainly around the physical environment, and various themed game activities are constructed according to the site characteristics. However, most educators and parents seem to pay more attention to the process and results of education and ignore the adaptability of children to the educational environment in the educational process.

A positive educational environment can encourage children to overcome the fear of leaving the familiar living environment and enable them to experience the joy of education and the temperature of the space. With active early childhood education as the research context, this study takes the educational construction of architectural space as the research path and through the systematic study on the construction of contemporary early childhood education space from the aspects of thematic education activities, teacher-child relationship, space construction, children's positive psychology, and environmental behavior. The research team conducted cross-boundary research with early childhood education institutions through participatory action research, actively exploring adaptive strategies for contemporary early childhood education environments and providing more possibilities for children's health and well-being through environmental space creation.



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## Paper 22

# Associating Concepts with Literature: The Expression of Literary Artistic Conception with Space As the Medium

**X. Wang, L. Zhao**

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**Keywords:** literary memorial space, literary atmosphere, strategic deconstruction, associating concepts approach

Under the background of deep cultural tourism, intensely activating cultural sites, activating cultural scenes, and seeking the logic of stories in the historical context has become the only way to develop cultural tourism. As a type of celebrity's hometown and memorial place, Chinese literati memorial space has a unique literary narrative context. How do we extract design logic from literary narration? How do we discuss the construction of literary context in the design prototype? This paper will describe the design prototype of the literati memorial space and further explore the literary and artistic conception constructed by the "Associating concepts" method to achieve the thinking of the design strategy of the literati memorial space.



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## Paper 23

# The Creation of Situational Experience in Consumption Space

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**Keywords:** consumption space, situational experience, consumer psychology, consumer behavior

In recent years, a large number of situational consumption scenes have emerged, which has triggered changes in consumer society. Through a comprehensive analysis of the changes and development of the consumer society, the development status and challenges of urban consumer space in the post-epidemic era are drawn. From the perspective of consumer psychology and behavioral changes, the author explores consumers' real emotional appeals for consumption spaces in the post-epidemic era in addition to specific functions and combines the successful cases of relevant contextualized commercial consumption spaces to create a contextualized atmosphere for consumption spaces. Discuss and summarize the significance of reshaping consumers' consumption experience in the current consumption space that focuses on creating a situational atmosphere. Analyze the cultural dissemination of art aesthetic education in situational consumption space, and summarize the necessity of creating a sense of situational experience in consumption space so that relevant art creators can conduct more in-depth exploration and research on the design of consumption space and cultural communication in the future. In this way, it is possible to create a consumption space that provides consumers with a unique and unforgettable experience. This, in turn, produces a more dynamic and prosperous urban consumption environment.



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## Paper 24

# The Role of Artistic Collaboration in Contemporary Architectural Praxis

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**Keywords:** contemporary architecture, artistic participation, façade, ornament, tectonic pattern, characterology

In my present study, I investigate the role and contribution of applied and autonomous art to contemporary architecture. I seek to answer the following two questions: (1) Which artistic disciplines regularly appear alongside contemporary architecture; and (2) what is the purpose of their contribution? My method is data distribution, analysis and classification that are focused on the visible outer shell of buildings, mostly the facade. I will present examples where artists took over the lead role as creators in a certain part of the building. My study aims to prove that, with physical interaction, this unique cooperation may enhance the complex value of the edifice. I call this a “traditional collaboration”, or, in today’s jargon, “professional participation”.





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## Paper 25

# Imaging Methods and Creating Illusions in the Practice of Architectural Design in the 21st Century

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**Keywords:** imaging, illusion, architecture

Imaging methods and creating illusions in the XXI. in the practice of architectural design in the 21st century - The differences in the effect of the architectural imaging methods, with particular regard to the coordination of the viewer's perception of the realized architectural work, through presented examples.

The influence of visualization techniques can be found in the architecture of recent decades. In our time, the rapid development of IT technology makes the use of professional visualization tools accessible to all architects. The use of different visual techniques broke down the limits of "creating illusions". The creation of reactive illusions mediated through a variety of visual imaging methods is becoming more and more prevalent.

In the current phase of my research, I am attempting to analyze the relationships between the photograph of the completed building and the previous digital visualization from the perspective of the practicing architect. Through photographs and renderings, I analyze the character-bearing elements of buildings - from several directions at the same time - looking for possible answers, with what tools and why a building can show different faces, through different visualization techniques. What is the relationship between the photos and visual plans regarding the pre-construction and final state of the building to be presented. How can favorable or unfavorable views and facades of the building be highlighted or covered?

The threefold structure of my discussion:

- the part valid in itself within the built object,
- spatial harmony within the construction area,
- overall effect adjusted to the construction environment.

I highlight the examples chosen and presented for the analysis of the topic from works created from the second half of the twentieth century to the present day.



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## Paper 26

# The Experimental Analysis of the Built Environment of Hiking Trails

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**Keywords:** experimental, analysis, built environment, hiking

An empirical study of the built environment of hiking trails, focusing on Hungary and comparisons with impressions from abroad. The study of the built elements of the natural environment will include all the objects from the starting point to the final destination, including the route, viewpoints, tourist huts, shelters, benches, fireplaces and signposts etc. The analysis focuses not only on objects and spaces, but also on the users: people's behaviour, orientation and use. The research is based on personal observation, but takes into account the experiences of others. Its aim is to use the findings to improve the visual and built environment of hiking trails and people's experience of it.



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## Paper 27

# Urban Color Landscape Planning under the Two-tier Relationship - A Case Study of Urban Color Planning in Beijiao Town, Shunde City

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**Keywords:** urban color landscape, color perception, upper and lower role relationships, urban color landscape operational model

Since the reform and opening up of China, China has entered into an unprecedented urbanization, both in terms of the scale and intensity of the urbanized landscape. In terms of the "volume" of construction, New China has achieved in just a few decades what many Western countries have done in a few centuries. With such rapid development, the urban landscape of China has changed dramatically.

"As a topic that cannot be avoided by the international academic community, the academic research and practical achievements in this field in China have been very poor so far. As China's urban construction is still in the process of development, the problems of "city" and "color" have become more and more obvious in the context of such development. Confusing architectural color matching, lack of effective guidance programs, and lack of attention to the theory have become problems that cannot be ignored in China's dynamic development.

This paper analyzes the current situation in the field of urban landscape color in China, and summarizes two different phases of urban color problems that exist at this stage. The first is the misunderstanding of "color" by practitioners in the operation stage, and the second is the misunderstanding of "urban color" in the cognitive stage. The author's understanding of "urban color" is derived through the elaboration and analysis of case studies. At the same time, through the author's personal participation in the "Shunde Beijiao city color and human geography research", "Shunde Beijiao city color application guidelines" as a case study, in the full text of the exposition of the use of interspersed with the full text of the way to argue.

Finally, through the conclusions of different chapters, the author tries to deduce a set of government-led, incentive for the masses to participate in the urban color construction of the operable model theory, mutual depth and improve the color landscape system in urban development.



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## Paper 28

# A Comprehensive Scoping Review Methodology for Exploring Living Labs in Architectural Research

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**Keywords:** living lab, architectural research, architectural domain, review

**Background:** Living labs, dynamic environments that integrate real-world settings with innovation and user-centered design, have emerged as transformative platforms for advancing architectural knowledge and practice. Their ability to merge theoretical knowledge with practical application positions them at the forefront of architectural research. Despite a growing body of literature, a clear overview of the applications in architectural research settings is still lacking.

**Aim:** The aim is to scope publications examining all types of LL activities within the architectural domain.

**Methods:** Our review will encompass a comprehensive examination of research papers, articles, and studies, aiming to provide a thorough understanding of the current state of living labs in architectural research. The bibliographic databases to be searched will include Web of Science, Scopus and Scholar, without date restrictions. We review only publications in English. The purpose of this paper is to describe the methodology and analytical procedures that will be employed for the systematic review.

**Results:** The bibliographic database searches will be completed in December 2023, retrieved articles will be screened, and the entire study is expected to be completed by May 2024.

**Discussion:** This scoping review will provide a global indication of the LL activities used for architectural research, shedding light on their diverse applications and contributions to the field. By identifying gaps and challenges in the existing literature, we aim to define clear research objectives for the enhancement of architectural living labs and their influence on architectural practice.



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## Paper 29

# Bonding, Personalization, Storytelling, Ritual: Experiments in Sustainable Furniture Design

**D. M. Pataki**

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**Keywords:** design, furniture, sustainability

The theme of sustainability is very significantly presented around us, both as designers and consumers. Designers can and even should adopt these materials and technologies into their work and on the consumer side shop ethically and consciously. Might be the fundamental problem is that true sustainability and consumption are in stark contrast. Could we, should we, intervene in this profit-driven process? Even if we cannot magically change everything, we can provide alternatives to consumption. The aim is to create an object design narrative and language that can be used as a guide, a tangible suggestion, a way of helping others to form an attitude. These design proposals are presented through own experimental craft works. A longer object life cycle is more sustainable. If we develop a bond to an object and stick with it, its life cycle may be extended. We can get a similar result by personalising it, involving the user, incorporating a positive experience or memory. Whether it's through a story to add positive content to an object, knowledge and understanding builds respect for the object. This can be reinforced by rituals, which are intentionally influenced actions that become part of the daily routine.



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## Paper 30

# Study of Historical Traces of Changchun City, China

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**Keywords:** historical public building, architectural heritage research

Since the founding of the New China, Chinese government has been giving priority to the protection of cultural relics in historical cities. Cultural relics management departments at all levels from the capital to the local level have set up urban historical and cultural assessment institutions according to the scale of large, medium and small, assessing the grade of historical and cultural relics in a scientific and orderly manner, and recommended to the UNESCO agency that China's outstanding urban culture should be declared as the world's cultural relics, so it would serve as a contribution to the enrichment of the historical civilization of mankind and the development of the Chinese value.

Changchun City in Jilin Province is located in the northeast frontier, which has a long history and it is a multi-ethnic settlement. Changchun is home to China's large-scale heavy industries and is the base of China's automobile manufacturing industry. The city has a large number of historical architectural heritage that have been well preserved to this day, some of which have been recognized as national cultural relics and provincial and municipal cultural relics.

The buildings under study represent some of the best design and construction in Asia from 1932-1945, and are characterized by the distinctive Manchurian style of government buildings. 2023 4x4 project focuses on the research and mapping of the historic public buildings of Changchun Xinmin Street. Research and analysis of this special historical city, in respect of its historical value based on the protection of historical buildings, emphasizing its special value as a special historical city, the remains of the building further redesign and re-use. The study emphasize its function and value as a special historical warning and patriotic education in the city.



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## Paper 31

# Research on the Renovation of Public Service Facilities in Age-friendly Communities in China

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**Keywords:** age-friendly, community, public service facilities

The current concept of "age-friendly" in the field of urban settlement environment comes from the description of age-friendly cities and communities (AFCC) in the 2005 World Health Organization "Age-Friendly Cities" policy framework: "A city or community that can reduce and improve the various problems people encounter in the aging process, is inclusive and accessible, and can promote active aging." Subsequently, more than 300 cities worldwide participated in the construction of age-friendly cities. AFCC has become an important research field under the study of aging and urban renewal. The Chinese government also used the term "aging-friendly" in a national document for the first time in 2016 in the "Guiding Opinions on Promoting the Construction of a Livable Environment for the Elderly" to guide the construction of a livable environment for the elderly.

China's urban renewal has experienced a transition from large-scale demolition and construction to refined renewal. Although the main functions of many early communities are intact, the supporting public service facilities can no longer meet the current living needs of the residents, and there is particularly insufficient consideration for aging suitability. Therefore, it is imperative to update community public service facilities under the concept of age-friendly community, and it is also a decision that conforms to economic development and people's demands.

Public service facilities are an important research object for community renewal. Especially from the perspective of age-friendly, public service facilities are more suitable for its welfare properties than other elements in residential areas. Through the study of public service facilities in age-friendly communities, we can understand how China's urban communities are and will serve the elderly in the community in the future, ultimately improving the quality of the living environment and the quality of life of the elderly.



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## Paper 32

# Xinhua News Agency Comprehensive Renovation Project of No.3, Yangfangdian Road, Haidian District

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**Keywords:** old buildings, energy renovation, anti-seismic reinforcement, functional building renovation, empty nesters

The community was built between late 1950s-2000 last century, which during this period the Chinese financial situation is not good. This resulted in buildings of that period can only used for residential purposes, lacking in reasonable floor plans, enough lighting, good insulation and stability. At the same time, due to the special characteristics of the residents of this community, this community is facing a more serious problem of population aging. In the past ten years, the Beijing Municipal Government has actively organized the upgrading and renovation of this type of old communities, the design for the Huangtingzi project was processed under this background.





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## Paper 33

# Revival Heritage Story: A Revitalization Journey of Transforming the Historical Houses

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**Keywords:** revitalization, reused houses, sustainable requirement, renovation

Historical Buildings and houses specifically provide tangible evidence related to the past and the present at the same time. The dwelling, as an inherently built heritage, represents the origin of humanity and how it began. As a sustainable requirement, reusing the exact house for another function will depend on several factors and determine several solutions. The functional requirements are one of the most important criteria for renovation and reusing projects all over the world. Residential in general needs to identify their layouts, space configurations, circulations, and accessibility of different types and how could meet the needs of new suggestions. All these considerations will be part of this research to have a systematic analysis of reused houses in the world.

The research will review many reused houses in the Middle East that have eastern properties and have a new life to find out the main factors for specific areas to preserve the historical values of these buildings to pay attention to the significant role of the new use to fit the old structure. Besides, regulations and guidelines for preserving certain historical buildings, sites have restricted rules which are different from one area to another. These case studies are, the houses in Erbil citadel, Iraq and Safranbolu in Turkey, these could be an example of conserved or reused houses under UNESCO supervision cooperating with local engineers and builders. Also, the research offers a good experience for other cases in some places to give a rich and clear knowledge about the challenges and constraints of the preservation process and reuse projects in the Middle East. Places with cultural heritage, promote tourism, and create economic opportunities for the places that have a rich since the leak of tourists and less background of the restoration process for historical buildings.

To conclude, this study provides insights into the difficulties and rewards of undertaking the complex process of preserving historic houses.



**Traditional Safranbolu Houses**

**Traditional Erbil Citadel Houses**

Figure 33.1: Case Studies Houses in Iraq, Erbil Citadel, Turkey



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## Paper 34

# Rehabilitation of Vernacular Architectural Monuments

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**Keywords:** vernacular, architecture, rehabilitation

Why is it important to save vernacular folk memories and how can we integrate them into today's architecture? I am looking for the answer to this in my doctoral thesis, which I would like to briefly present through the example of my 123 year old farmhouse in Mátraszele, Nógrád county, which is currently being renovated. In my presentation, I will explain my architectural creed, and then I will present the steps on the way to complete renewal. I also received financial support from the Teleki László Foundation's Vernacular Architecture Program, which I will cover briefly.



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## Paper 35

# Research on Reconstruction Design of Diaojiaolou Residential in Guizhou China Terraced Field

**Q. Cui, P. Zilahi**

*University of Pécs, Hungary*

**Keywords:** dwell houses, protection, transform, homestay, terraces

Nowadays, it is a high-speed era of economic development. The people's requirements for quality life are constantly improving. The tourism industry has caught the ride of the times and is developing in full swing. With the continuous development of the country's rural tourism resources, many regions rich in tourism resources have been continuously explored, driving the continuous development of surrounding traditional residential houses. People no longer just appreciate the scenery and sightseeing for travel, but emphasize the sense of experience and participation in travel. As a result, emerging industries such as homestays and resort hotels have developed rapidly.

In order to protect the traditional residential houses in Guizhou and to upgrade the quality of the local homestay industry, the traditional residential houses and the homestays are combined to be renovated and transformed. The traditional residential houses are transformed into bed and breakfasts, which not only protects the traditional residential houses, but also finds a new survival path for traditional residential houses, And has improved the quality of the homestay, providing tourists with a unique cultural and historical travel accommodation experience. Therefore, this article hopes to explore the new way out of traditional houses and the new development model of the space of the house by carrying out the design and transformation of the traditional houses' hanging houses.



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## Paper 36

# Adapting Mongolian Yurts for Modern Lifestyles: A Comprehensive Case Study

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**Keywords:** Yurt (Ger), climate change, vernacular, architecture, urban sprawl

In 1992, Mongolia underwent a significant transition from a centralized economy to a free-market system, resulting in profound societal changes. The population of Ulaanbaatar, the capital, has witnessed a remarkable transformation: from a mere 10,000 in 1935, it surged to 668,800 by 2000 and has currently reached an unprecedented 1.6 million. This surge is attributed to the influence of income levels on housing choices, especially among rural-to-urban migrants, leading to urban expansion in Ulaanbaatar. Data from the 2020 population housing survey reveals that 22.2% of the capital's residents still prefer traditional housing, underscoring a persistent demand for such Yurt. This observation underscores the ongoing impact of Mongolia's urbanization on the traditional nomadic lifestyle, reflecting a modernization of Mongolian Yurt. Our research tries to study in depth the evolution of Yurt in modern Mongolia, with a special focus on Yurt (Ger) solutions that are used in winter heating and energy saving technologies that are compatible with modern lifestyles.



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## Paper 37

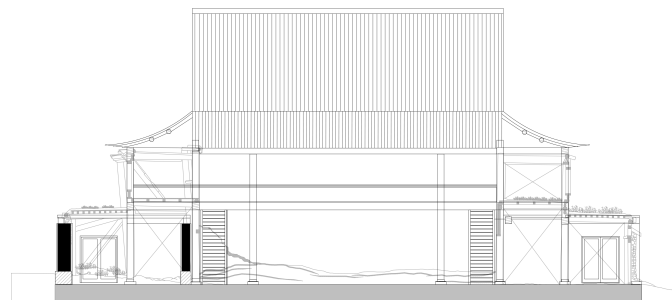
# Contemporary Approach to Preserve and Repurpose Mongolian Temples

**E. Gombo-Ochir, T. Molnár**

*Marcel Breuer Doctoral School of Architecture, University of Pécs, Hungary*

**Keywords:** Mongolia, Mongolian temples, preservation of temple

This paper explores innovative and contemporary approaches to preserving and repurposing Mongolian temples, with a focus on maintaining their cultural and historical significance while adapting to modern needs. It examines the unique architectural and cultural aspects of these temples, and the challenges they face, and presents design and preservation strategies that can ensure their continued relevance.



PRESERVATION PLAN SECTION 1-1  
TUDGCHEN DUGAN, ZARA GEDEEN COMPLEX MONGOLIA



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## Paper 38

# Architecture Without Architects in the 21st Century

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**Keywords:** architecture without architects, recycled architecture, circular economy

The presentation examines how twelve people living on the periphery of society designed their own home in a Hungarian settlement without the help of architects. The purpose of the research is to shed light on the phenomenon of "architecture without architects" by examining the design, construction and social aspects of the participants' self-built homes. (1) The survey sketches and architectural drawings produced as a result of the study help bring this kind of instinctive architecture and academic architecture closer together. Without architects, this architecture is hidden from a significant part of society. Nevertheless, they serve as many good examples for the majority society in the formulation of answers to social challenges that need to be solved. (2) This study also helped to discover whether humans retain some of their ancient home-making instincts, which allow them to create their own personal environments even if their financial means do not allow them to do so in a regulated building environment and in a highly polarized society. Using qualitative methods such as interviews, observation and documentation, the study explores how participants used local materials, traditional techniques and their own creativity to build affordable and functional homes. (3) Overall, the study provides insight into the potential of self-build housing as a solution to the housing needs of low-income communities.



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## Paper 39

# Study on Updating Strategies of Transforming from an Old Industrial Estate to an Industrial Heritage Community

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*Faculty of Engineering and Information Technology, University of Pécs, Hungary*

**Keywords:** industrial community, eco-museology, community renewal, urban design

The decline of industrial communities is a common phenomenon worldwide. In China, state owned enterprises influenced by state capital developed rapidly soon after the foundation of the People's Republic of China. Many living communities centred on enterprises and factories have been built and equipped with advanced facilities and effective management systems. However, many workers have become unemployed and laid off due to the privatization of state-owned enterprises. In such cases, the industrial communities dependent on factories cannot develop and the system may collapse. This can cause communities to decline gradually, with old communities becoming seriously disconnected from urban life, which can generate a series of serious urban problems, such as the ageing of material space and the breakdown of social relationships. Therefore, how to make marginalized and closed industrial communities actively integrate into re-urbanization development and become an organic part of the urban community through the renewal and development of industrial communities will become a new issue for future urban renewal.

This study aims to formulate research-based designs for typical old industrial communities. The community affiliated with the Yujiao Lianxin Industrial Estate in Jingzhou City, and the research design was conducted by obtaining relevant information through research on relevant social sectors and resident groups, and considering social and economic capital issues. Finally, three renewal strategies for industrial communities are proposed: overall community restructuring, residential reconstruction and expansion, and revitalization of the community's industrial heritage and public space, which provide samples with certain reference value for the renewal of old industrial communities.





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## Paper 40

# Master Plan Applying Possibilities in the Hungarian Urban Development Environment and Regulatory Practice

**A. B. Sütő**

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**Keywords:** master plan

The domestic urban planning environment does not apply the concept of Master Plan. Although the concept has become more and more common in the last decade and many such plans have been drawn up, there is no further legal regulation on this method. Since the Master Plan is indisputably a tool that helps to mediate the cooperation of public and private sector, it is therefore worth examining what possibilities there are for the application of this type of plan within the current legal framework and bureaucratic operation.

Currently, the plan is mainly used in large-scale real estate developments undertaken by the private sector, but it has many other uses as well.

International practice lists numerous examples where the Master Plan is a mandatory condition for changing any kind of regulation. At the same time, the type of plan is also a tool for the precise definition of grassroots urban renewal initiatives, and for launching urban renewal programs too.

The question is, how long can the domestic rise of the genre be sustained only because of the growing professional acceptance, and when will it become necessary to incorporate this type of design tool into the bureaucratic practice of planning by creating the necessary legal frameworks?



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## Paper 41

# The Reconditioning of the Market Hall of Pécs in the Context of the Sustainability - Environmental Emergency and Architecture through an Academic Semester

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**Keywords:** sustainability, reconditioning, revitalization, heritage, architecture

The survival of humanity depends on the usage of energy since the beginning of creation. The basis of sustainability is always based on well-thought energy consumption, but unconsumed energy can serve better the protection of the environment as a prevention. Sustainability means that we keep the opportunity for future generations to ensure their own living conditions. All research and studies related to sustainable development emphasize the necessity of a change of attitude and the responsibility of universities in its implementation. The academic class like engineers, political - economic decision-makers are going to define the future of the society, what society will be able to create the balance and the “fair play” between the environment, society, nature, and economy, and to undertake a responsibility. What can we do as architects to promote a change in attitude?

During an academic semester, students at the University of Pécs had a project about current social-economic issues in architecture and urbanism. The task was to recycle the vacant building of the Market Hall of Pécs and the surrounding city block. The solutions show that sustainability is not only important when designing new buildings, but it is also our duty to recycle our existing built infrastructure.



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## Paper 42

# The Image of the City from the Perspective of the Medium

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**Keywords:** urban imagery, medium, perception, McLuhan

This paper studies the elements of the urban image through the pan-medium theory constructed by the medium environmental school. As an important dimension of people's cognition of urban structure, city image constructs mental mapping of urban space through perception and experience elements. This paper analyzes the evolution of McLuhan's theory from "the medium is the message" to "everything is the medium," classifies the attributes of medium from natural medium and artificial medium, and discusses how different kinds of medium shape the city image through the transmission and interaction of information. Based on the formation mechanism of city image proposed by Kevin Lynch, this paper further reveals the relationship and influence mechanism between natural medium and artificial medium in the construction of city image. Natural medium mainly focuses on the perception of the natural environment to generate the impression of the city with unique style and characteristics. Artificial medium focuses on the artificial environment of the city, such as buildings, roads, and squares, and directly constructs and strengthens the mental impression of the residents of the city's paths, nodes, and landmarks. This paper compares and analyzes the different characteristics and paths of the two types of medium in transmitting urban information, shaping urban images and their performance in residents' mental images, and shows their different roles and influences in the process of reconstruction, regeneration, and transformation of urban space. Starting from the theoretical system of medium environment school, this study broadens the vision of urban image research and proposes a new theoretical perspective and analytical framework through an in-depth analysis of the mechanism of medium in the construction of urban image, which provides beneficial theoretical support and inspiration for future urban research and practice.



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## Paper 43

# Water Management of the Green Gate Project in Pécs City, Hungary

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**Keywords:** sustainability, urban planning, sponge city concept, water management

Cities across the globe are undergoing transformation and progress in the direction of greater sustainability due to a range of factors. This shift is motivated by the imperative to confront critical environmental, societal, and economic issues, including the enhancement of living standards and the mitigation of global challenges like climate change and pollution. One key approach involves the reevaluation of urban planning strategies and the expansion of green spaces.

An example of a city actively pursuing its development in this regard is Pécs, situated in Hungary. Pécs is undertaking a series of projects, one of which focuses on the "Green Gate." This initiative aims to transform the urban landscape by introducing new pedestrian walkways, enhancing sidewalks, and expanding green spaces in the city.

In order to optimize the upcoming project's impact, I am directing my focus toward the management of water supply within this specific region. This encompasses the assessment of the existing water infrastructure, estimation of water consumption patterns, and exploration of the viability of incorporating elements inspired by the "sponge city" concept. Our objective is to gauge the potential results and evaluate the feasibility of applying these approaches.



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## Paper 44

# Achieving Adaptability through Various Urban Housing Typologies

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**Keywords:** adaptability, flexibility, urban housing, contemporary urban living

As cities continue to grow and diversify, urban planners, architects, and designers are faced with the challenge of creating housing solutions that can flexibly respond to a multitude of demands and changes over time. This rapid change in the urban landscape necessitates adaptable housing design typologies to meet the evolving needs of urban residents. Several residential building models, typologies, and solutions have emerged with the aim of solving the problems arising from overpopulation. Some of them have succeeded, while others have failed. This paper aims to shed light on the importance of adaptability in urban housing design and its potential to enhance urban living environments. The concept of adaptability in urban housing typologies does not only focus on the dynamic nature of urban environments but also addresses critical issues such as sustainability, affordability, and livability. This paper provides a comprehensive review of adaptability through different urban housing typologies that explores the concept, its significance, and various strategies employed in achieving adaptable dense housing solutions.



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## Paper 45

# From Ideal to Reality - Systematic Innovation and Exploration Practice of “Future Community” in Zhejiang, China

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**Keywords:** future community, Chinese urban plan, functional unit, humanization design

China's Zhejiang Province proposed the concept of “Future Community” in 2019, aiming to design scenarios of the future community life of Chinese residents to create a sense of belonging, comfort and futuristic new urban functional unit. As of 2023, this concept has been developed for five years and has gradually affected a large number of communities construction and creation in Zhejiang Province and even across the country. Many of its ideals have become realities. Based on the research of the “Future Community” group of the China Academy of Art, this article will review the systematic exploration of “Future Community” in Zhejiang, China, analyze it with practical cases of actual participation, and discuss the important innovations.

This article first starts with the thinking about the “Ideal City” in human history, from the utopian stage in end of the 19th century and before was the ideals and art orientation, to the technological response stage in the end of the 19th century to the 20th century was oriented towards resolving urban diseases, and since the end of the 20th century, the diverse exploration stage guided by sustainable concepts. From this, we summarized the three major future development trends of “people-oriented”, “digital intelligence” and “ecological livability”. The three major value orientations of “Humanization”, “Digitalization” and “Ecologization”. However the most important core of the “Future Community” concept is “People's longing for a better life”.

As the concept of “Future Community” has been implemented in China for five years, we have also witnessed the construction and creation of many communities. This article also analyzes the practical cases that the author participated in, and demonstrates the feasibility and degree of realization of the theory through practice. And the resulting expectations and prospects for the future community life, environment and connections in China and even the world.



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## Paper 46

# The Bridge Between Product Design and Architecture in the Context of Building Facades

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**Keywords:** pre research stage, interdisciplinary cooperations

Architects lead a complex design process before their projects arrive to the construction phase. What is the best time to involve a product designer to have a relevant cooperation of the two fields?

Historic houses with rich traditions and contemporary buildings with innovative construction and aesthetic solutions exist together in hungarian cities, as well as in the tiniest villages. Municipal design handbooks have an effective role in harmonising the appereance of the streets, helping the coherent design with relevant support. The visual harmony of smaller-scale accessory elements and objects of the building have been in my focus of interest since my early career. Special attention is paid to these accessories in case of buildings with longer ownership histories, since they are installed subsequently in many cases, sometimes using the street facade, heavily effecting the building's appereance.

# **Civil engineering**







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## Paper 47

# Imperfect Geometrically Nonlinear Reliability-Based Topology Optimization of Steel I-Beam

**M. Habashneh, M. Movahedi Rad**

*Széchenyi István University, Hungary*

**Keywords:** steel I-beams, geometrically nonlinear, geometric imperfection, topology optimization, reliability-based design

This study proposes a methodology for conducting reliability-based topology optimization (RBTO) technique of geometrically nonlinear analysis while considering the presence of initial imperfections. This approach takes into account the random nature of volume fraction and initial geometric imperfections, as they significantly influence the feasibility of manufacturing web openings in steel I-beams. In the case of probabilistic design, the reliability index is considered as a constraint related to the reliability condition added to the volume fraction. The plastic behaviour is governed by utilizing the concept of limit analysis, which imposes constraints related to plastic ultimate load multipliers. Additionally, the present work incorporates the use of the bi-directional evolutionary structural optimization (BESO) technique. The efficacy of the suggested methodology is substantiated via comparing the results of the optimal topologies of the proposed technique with benchmark problem of steel I-beam with ordinary web openings. The chosen approach has clear promise in enhancing the load-bearing capability of the I-steel beams while maintaining the same material amount within the designated design area.



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## Paper 48

# Model Factor for Patch Loading Resistance of Steel Plated Structures

**E. Bärnkopf, B. G. Kövesdi**

*Budapest University of Technology and Economics, Hungary*

**Keywords:** patch loading, model factor, steel, numerical model

Direct resistance check by using numerical models is an alternative and increasingly used method for the design of steel structures. This design method has to take into account the same uncertainties as traditional analytical calculations and should ensure the same safety level. Therefore, in addition to the uncertainties already covered by the partial safety factors on the resistance side, the uncertainty of the numerical model should also be taken into account. To cover the uncertainties of the numerical model, the model factor is introduced, which determination is a unique task, to be made for all failure modes and design methods. This study focuses on one particular failure mode: patch loading resistance of slender plated structures, and investigates the numerical model uncertainties.

Previous research results show that three different failure modes can be developed in longitudinally stiffened plated structures depending on the position, the slenderness ratio of the longitudinal stiffener, and the loading length. In the present study, so-called strong stiffeners are investigated which localize the failure model to the local sub-panels, ensuring a local buckling-type failure model. Eight large-scale specimens are tested in the laboratory of the BME Department of Structural Engineering to determine the patch loading resistance of steel plated structures. The results of this program are used to assess the model uncertainties within the current study. A numerical model has been developed to recalculate these test results. Several physically possible and reasonable modeling differences are introduced in the numerical model development and their effects are analyzed on the calculated patch loading resistance. The sensitivity of the numerical results compared to the accurate test results is evaluated and discussed in a detailed manner. The final aim of the investigation is to determine the appropriate model factor for this girder type and failure mode based on the statistical evaluation of the numerical results.



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## Paper 49

# Numerical Modelling of the Shear-lag Effect in Tensioned GFRP Bars

S. Szinvai, T. Kovács

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**Keywords:** GFRP, tensile strength, shear-lag effect

Glass fibre reinforced polymer (GFRP) bars have several advantages over traditional steel bars, such as corrosion resistance, light weight, and high tensile strength, which make them a reasonable choice for improving the durability of concrete structures.

FRP bars are composed of fibres and a matrix material. The fibres are the primary load-bearing components, providing the strength and rigidity of the composite. The matrix, on the other hand, binds the fibres together, transfers the loads between them, and protects them from environmental and mechanical deteriorating effects.

This paper investigates the shear-lag effect in glass fibre FRP (GFRP) bars. The effect decreases the tensile strength and depends on the diameter and the fibre volume ratio. The primary focus of this study is the investigation of the intensity of the shear-lag effect at varying fibre volume ratios and diameters.

The investigation was based on numerical models developed in the Atena software. A standard tensile test setup was modelled. The GFRP bars were subjected to tensile force until failure. The anchorage of the bar during the tensile test was modelled by surface springs. A parametric study on the effect of the stiffness of surface springs on the intensity of shear-lag was also conducted.

The fibres and matrix were modelled separately, with known material properties. The results of the numerical model were compared with manufacturers' data and results from previous experiments found in the literature.

The findings of this study deepen the understanding of the tensile behaviour of GFRP bars. Nonetheless, other factors that influence the tensile properties of GFRP bars must be analysed through supplementary laboratory experiments.



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## Paper 50

# An Experimental Evaluation of the Effects of Geometric Imperfections and Misalignment of Connection Elements on the Lateral Stability of an Assembled Precast Prestressed Reinforced Concrete Beam

W. S. Hameedi, I. Volgyi

*Budapest University of Technology and Economics, Hungary*

**Keywords:** lateral torsional buckling, lateral stability, bolt connection

The present study aimed to examine the lateral stability of an assembled girder. The girder is composed of a precast prestressed reinforced concrete component measuring 35 m in length. This central section span is increased by two normally reinforced concrete (RC) components on each side, each measuring 2.5 m in length. The three components are connected using a special bolted connection. A 50 mm space was maintained between each pair of connected components, which was subsequently filled with a mortar that has the ability to expand. This was done to ensure the even distribution of forces between the connected parts. This study examined two types of imperfections: the first pertains to the initial geometric imperfection of the girder, while the second concerns the misalignment of the connecting components that join the three sections together. A total of five experimental tests were performed on a pair of specimens. The initial two experiments were conducted on two specimens exhibiting different levels of defects. It is important to note that this study just focuses on the measurement of geometric imperfections at the outset. The subsequent three experimental trials were likewise performed using two specimens. The central components utilized in these tests were identical to those employed in the initial trial. However, the normally reinforced segments were recast as a result of notable deformation occurring in the connection zone due to an oversight in the dismantling operation. A nondestructive loading plan was implemented to assess the lateral stability of the whole girder. Following the initial two experiments, a series of modifications were implemented to the test configuration, resulting in a more robust girder and a substantial enhancement in its buckling load.



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## Paper 51

# Retrofitting of Structures Subjected to Seismic Activities

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**Keywords:** earthquakes, structures, retrofitting, frequency, intensity

Recent earthquakes in Turkey, Syria, and Afghanistan have claimed thousands of lives, caused millions of people to be displaced from their homes, and affected economies badly. Structures designed according to earlier codes are highly vulnerable nowadays due to the frequency and intensity of earthquakes having increased gradually as it was decades ago. Improving the safety of such structures requires retrofitting or strengthening of structures against earthquakes. The main aim of this research is to analyze such pre-code structures that are subjected to possible extreme seismic events and design vulnerability analysis and retrofitting techniques that are economically adaptable and will help the structures to resist extreme seismic events. The methodology is to do the seismic analysis of a built pre-code structure by using different software and check its resilience against earthquakes. Further same structure will be analyzed after applying different retrofitting techniques and the results will be compared.



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## Paper 52

# Resilient Design of Structures Subjected to Extreme Effects

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**Keywords:** blast application, fragility analysis, shape memory alloys, resilience analysis

The recent increase in severe incidents, such as both intentional and accidental explosions, underscores the necessity of examining structures' ability to withstand extreme conditions. Resilience, is a structure's capacity to endure adversity and recover its intended functionality, has gained paramount importance due to the rising risks associated with various disasters and accidents. This study specifically investigates the resilience of steel structures equipped with specialized Nickel Titanium Shape Memory Alloy (NiTi SMA) connections when exposed to blast loading. The study encompasses structures of different heights, ranging from 4 to 15 stories, which are subjected to explosive forces ranging from 1000 to 20000 kilograms. To assess the structures' ability to endure such challenges, probabilistic fragility analysis is applied to gauge the probability of structural failure during explosive events. The study's outcomes underscore that these steel structures exhibit noteworthy resilience, as they maintain their structural integrity even when confronted with substantial explosive forces, including magnitudes as high as 20,000 kilograms. This has far-reaching implications for bolstering safety and safeguarding lives and property in regions prone to explosive incidents.



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## Paper 53

# Prototyping and Testing of a Low-cost Indoor Mapping System

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*Slovak University of Technology in Bratislava, Faculty of Civil Engineering, Slovakia*

**Keywords:** mobile mapping system, SLAM, lidar, inertial measurement unit, stereo camera, testing

The paper focuses on the prototyping and testing of a mobile mapping system for laser scanning the indoor environments of buildings. The prototype consists of a combination of a trio of 2D lidars, a 3D lidar, an inertial measurement unit, a stereo camera, and a rotation sensor. Data processing utilizes the SLAM approach. The individual components of the system form three subsystems, which are described in detail. Part of the paper is dedicated to the proposal and execution of a series of tests. Through component testing, we assess the quality of the collected data and, subsequently, the quality of the entire mobile mapping system. The paper concludes with the presentation of the test results. Furthermore, the paper discusses future work and the possible applications of the mapping system.





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## Paper 54

# Software Solution for Automated Verification of Wall Structures Written in Python

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**Keywords:** point cloud segmentation, building information modeling, python, IFC, terrestrial laser scanning

Automation in the construction industry, which has significantly enhanced efficiency and process optimization, has seen substantial progress in using modern techniques of spatial data collection. This progress has led to growing interest in processing and analyzing point clouds - three-dimensional sets of points collected using various methods, whether it be photogrammetry or laser scanning. All of this has opened new perspectives for the verification of construction structures.

This paper discusses using point cloud data to verify wall structure geometry, with geometry information extracted from Building Information Modeling (BIM) models as the reference data source. We focus on automating the verification of wall structures using a software solution developed in Python. Our research involves processing and extracting geometric data from BIM models in IFC format. We segment wall structures from point clouds obtained by Terrestrial Laser Scanning (TLS), compare the data obtained, and visualize deviations. Finally, we give practical recommendations for achieving better results, conclusions, and plans for future work.



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## Paper 55

# Automated Pointcloud Processes for BIM Methodology Purposes

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**Keywords:** point cloud, automation, algorithm, python, AI

The following research was made within the “Kriszbacher Ildikó Talent Development Scholarship” with the support of the BIM SKILLS LAB. The purpose of this research was to be a prestudy for a greater scope of research with point clouds. The scope of this study is to analyze point cloud processes and automation capabilities that are followed by BIM modeling methodologies. In previous research, I investigated the automatable methodologies based on 2D DWG and PDF files. The main scope of the previous research was to analyze the stored and extractable data from the file formats, and also define the add-on information that is needed to automatically make 3D BIM models out of DWG files. In this study and also in further research, I would like to extend the previous scope to 3D data for modeling, starting with 3D point clouds. Processing a point cloud manually could take days even weeks, the following modeling goes up to months. The methodologies used during processing and modeling are repetitive, with the modern point cloud processing tools and AI I think these processes could be automated. With programming these tasks and processes, the required time could be reduced to days, maybe even hours. In the research scope, I will analyze free, open-source point cloud processing software, as well as free AI models that are connected to point cloud classification and processing. The previous and further research will support my future Ph.D. dissertation, where I would like to connect these studies with increasing scope.



## **Developing More Accurate UA-based Stereo-photogrammetry Methods**

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**Keywords:** unmanned aircraft, building survey, accuracy

Nowadays Unmanned Aircraft (UA) based survey methods are popular, but their accuracy is debatable. Regulations have had a major impact on the use of UA and these regulations have had a negative impact on the spread of the technology. Many rules must be adopted during the measurement process and hundreds of settings have to be used during post-processing. Many combinations must be tested and evaluated to define optimized workflows. This research compares methods and procedures and provides a basis for a more in-depth analysis. A case study will be presented where the UA has been used with different rules and also the post-process was varied. The study examines the advantages and disadvantages of using UA and according to the results examines a comparison between the tested methods. The research highlights some future possibilities for developing procedures.



Figure 56.1: Generated point cloud by using 3DF Zephyr



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## Paper 57

# Adaptation of the Method of Road Safety Inspection to Railway Level Crossings

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**Keywords:** road safety, railway level crossings, road safety inspection

In recent years, the number of road traffic crashes showed a decreasing trend in Hungary, but this cannot be said about crashes at level railway crossings. The Hungarian State Railways has repeatedly called attention to the dangers of rail transport. In this paper, we present the latest developments related to level railway crossings. The main goal of the paper is to test the existing road safety inspection method in case of level railway crossings. Based on the experiences of road safety inspections done at ten railway crossings we give suggestions for the adaptation of the method to railway crossings. The most important findings of the safety inspections are also presented in the paper.



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## Paper 58

# The Impact of Public Transport on the Level of Development of Small Villages

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**Keywords:** public transport, rural transport, small settlements

In Hungary, in the second half of the 20th century and the beginning of the 21st century, numerous transport reforms were carried out in the field of public transport. The transport concept of 1968, followed by the railway closures of 2007 and 2009, were drastic interventions in the life of small regions, changing mobility habits and opportunities. In some regions, transport options were eliminated, forcing many people to leave their jobs and schools. The majority of the population of small settlements in Hungary is more socially vulnerable than those living in cities and agglomerations, and this is particularly true for the age group who do not yet own a car.

Despite the changes that these reforms have brought about in the life of individual small municipalities and small settlements, there are hardly any publications in the domestic academic literature that have examined the impact of these interventions on settlements. Looking at the international literature, the neighbouring countries have put much more emphasis on this topic, as we can find numerous Czech, Slovak or Croatian sources, but also some publications from the American and Asian regions. The aim of this article is to give an insight into the life of some of the small regions that have been radically changed by the dismantling of the former transport system. In this article I will explore possible solutions to solve or partially solve the transport problems of these areas. One of the most affected areas of Hungary is the Ormánság region of Baranya County, where after the regime change the transport system should have been radically changed in order to maintain its efficiency, but these steps have not been taken until today. Another important factor to be taken into account, based on international literature, is that transport is not only important for people living in rural areas in terms of access to employment and education, but also affects social inclusion, i.e. a deterioration in transport opportunities can increase geographical segregation.



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## Paper 59

# Non-Destructive Detection of Algal Biomass on Building Material Surfaces

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**Keywords:** algae, chlorophyll, façade, fluorescence, microbial colonization, supramural

Building façades are colonized by microorganisms. Algae in particular are known to conquer all ecological niches. In the meantime, the focus of current development is no longer only on control, but also on targeted establishment. Bio-receptive façades can contribute to climate regulation and CO<sub>2</sub> sequestration by supramural microorganisms in urban centers. Regardless of whether the goal is to control or grow algae on building material surfaces, quantification of the biofilm is required in both cases. For this purpose, samples are usually taken and measured in the laboratory. This inevitably affects the results, since sampling, transport and sample processing never corresponds to the growth conditions on site.

In the present work, a mobile measurement system was tested that combines non-destructive detection of algal biofilms including differentiation without the need for in-depth microbiological expertise. Algal pigments are selectively excited by coloured LEDs and emit natural fluorescent light with high sensitivity. The intensity of the chlorophyll-a fluorescence is used to calculate the different algae classes, in this case green algae, blue-green algae and diatoms.

The low detection limit of 0.1 µg/cm<sup>2</sup> chlorophyll-a ensures the earliest possible evaluation. At this stage, algal biofilms are not visually detectable and are also particularly sensitive. The handy format enables measurements to be taken even in complex installation situations. The validation of the non-destructive detection method was carried out in a two-year outdoor weathering and laboratory scale algae-suspension tests.



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## Paper 60

# Water Retention Equipment in the Urbanized Areas

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**Keywords:** rainfall-runoff process, urbanized areas, water retention equipment

With the increasing prevalence of construction zones and the continuous growth of construction activities, the adverse consequences of current drainage systems are becoming increasingly evident. Societal development is not only a significant change in the precipitation-runoff process in the catchment, but also a constantly deteriorating quality of surface and underground waters. In an effort to protect recipients from pollution from such urbanized areas, a new philosophy of urban drainage arose, leading to the sustainability of rainwater in an urbanized landscape. The basic principle of a sustainable approach is the concept of close to nature rainwater management, which tries to preserve or imitate the natural runoff characteristics of the basin before urbanization to the maximum extent possible. Water retention measures in an urbanized country, primarily aimed at regulating the water cycle, today also represent another significant benefit. They fulfill the function of the most effective climate measure in cities. They represent a system of natural elements that are able not only to aesthetically beautify public spaces, but also help to moisten and purify the air. They produce the oxygen we breathe and, last but not least, reduce the urban microclimate. In order for their implementation to be meaningful in an urbanized country, it is important that all measures are prepared and implemented as a systemic change of integrated territorial strategies in the regions and are part of projects not only in the case of the construction of new buildings and infrastructure, but also in the case of renovations.

## 60.1 Acknowledgment

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## Paper 61

# Mathematical Modeling of Surface Runoff for Optimization of Sewer Network Operation

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**Keywords:** hydraulic capacity, sewer network, mathematical model, computers software, wastewater

Sewer networks are among the most important part of utilities in urban infrastructure, they serve to safely and health-free drainage of wastewater from urbanized areas and their subsequent health-free treatment. At a time when there is a high increase in urbanization of cities, it is necessary to reconsider the state of the obsolete, insufficiently proposed state of the sewage networks. Now, we observe the biggest problem with the sewer networks of their insufficient hydraulic capacity, when the cross-section of the pipe is filled up to its upper edge and from the free-level flow it turns into a pressure flow. And so, the sewer is considered hydraulically overloaded. The main aspect of the project will be to design a mathematical model that will serve to model different load states for the sewer network in a given interest area.

Many computers softwares have been created to model the sewage network and surface runoff, which can simulate rain events for us. The most famous computer software includes CivilStorm, Storm Water Managment Model also known as SWMM or MikeUrban.

Inputs for our mathematical model will be obtained using measurements that will focus on recording rain events in a selected area, monitoring water quality in a recipient, and monitoring the sewer system. The output of this work will be a mathematical model for a given area of interest, which we will be able to simulate various loads for the sewer network system.





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## Paper 62

# Analysis of the Operation of Domestic Wastewater Treatment Plants

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**Keywords:** domestic wastewater treatment plants, inspection technicians, central database, standardized inspection procedure, quality of wastewater

Recently, in Central Europe, we can observe an increase in the percentage of residents connected to wastewater treatment plants and public sewers. All over the world, the accepted solution for wastewater disposal is a centralized approach. In areas with unfavorable conditions, where it is not possible to build a centralized system, such as small villages, marginalized areas, lazos and locations with scattered buildings are recommended to use decentralized wastewater management. At the moment, we do not register any database of domestic wastewater treatment plants on their condition and the quality of wastewater discharged into the environment in the Slovak Republic.

It is for this reason that a thorough and effective analysis of the current state of operation of domestic wastewater treatment plants and the creation of a central database on domestic wastewater treatment plants, their condition, the quality of discharged wastewater, and a proposal for a standardized inspection procedure for inspection technicians when inspecting domestic wastewater treatment plants are important.



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## Paper 63

# Sustainable Wastewater Management in Conditions of Slovak Republic

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**Keywords:** wastewater, sustainable solutions, wastewater management

More than 10 years have passed since the release of the report sick water by the UN. The central role of wastewater management in sustainable development- A rapid response assessment report, and despite some progress, significant amount of wastewater is still being released untreated into the environment. Untreated wastewater is one of the key drivers of biodiversity loss and a major threat to human health, particularly affecting the most vulnerable people and ecosystems. But when adequately treated, wastewater can become a valuable resource. The topic considers how to develop and extend these solutions to locations where improved wastewater management is desperately needed. In terms of water, not only the quality of water bodies has worsened due to contamination from human activities, but there has also been increased withdrawal and consumption of water resources. For these reasons, the number of regions in the world with hydric stress has grown considerably—even regions with a regular precipitation regime. In this scenario, it is compulsory to adopt a paradigm change, as far as the consumption of resources by the population is concerned, to achieve a circular economy. The recovery and reuse of resources are key points, leading to a decrease in the consumption of raw materials, waste reduction, and improvement of energy efficiency. This is the reason why the concept of the circular economy can be applied in any industrial activity, including the wastewater treatment sector. With this in view, this topic manuscript focuses on demonstrating the challenges and opportunities in applying a circular economy in the waste water sector.



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## Paper 64

# Unsaturated Groundwater Flow in the Szigetköz Region

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**Keywords:** modelling, groundwater, flow, hydrology, floodplain, infiltration, rainfall, evapotranspiration, colmation, flood control, hydrus

This study focuses on measuring and modelling the effects of saturated and unsaturated groundwater flow in the Szigetköz Region in Northwestern Hungary. The area contains a rich variety of natural resources for fishing, farming, tourism, and is a vital component of the Danube River ecology. Managing the region requires a balance between these competing stakeholders and requires a comprehensive understanding of the regional hydrology, hydraulics, and environmental processes. To better understand the hydrology of the region, we are examining the impacts of changing water levels in the Danube Main Channel, the Mosoni-Danube and control channels within the adjacent floodplain. The analysis will require an accurate assessment of surface infiltration of rainfall into the shallow groundwater table. The first step is modelling the 1-dimensional process of rainfall infiltration, evapotranspiration the fluctuating groundwater table over time. Arriving at a reliable estimation of groundwater recharge for the area is the first goal of the study. The process is complicated by natural and man-made processes such as seasonal flow variations, colmation of the channel beds, agricultural practices, flood control activities, and power generation at the Gabčíkovo Hydraulic Power Plant. Initial studies will model the 1-dimensional (vertical) movement of water into typical soil profiles in the region. Meteorological data as well as topographic information, channel levels, crop selections, and local pumping data will furnish the input information for the software, Hydrus, to estimate movement of water throughout the specific soil column. These models will be extended to 2- and 3-dimensionsonal representations to generate more realistic (and complex) evaluations and predictions.

# **Information Technology**





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## Paper 65

# Solving a Final Exam Scheduling Problem with Constraint Programming

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**Keywords:** final exam scheduling, scheduling, operations research, constraint programming

Scheduling problems appear in a wide range of fields, such as education, industry, transportation, and healthcare. Final exam scheduling is a subtopic of scheduling, which involves the management of numerous complex, varied, and often conflicting requirements, regarding large numbers of variables.

This paper examines a real-world problem of final exam scheduling for a heterogeneous group of 101 students of Budapest University of Technology and Economics (BME). A constraint programming model is proposed for the problem, specifying the various constraints having different levels of strictness and penalty scores. The problem includes many difficult-to-handle constraints, such as heterogeneous groups, parallel examination, leaks in the schedule, and workload balancing across multiple roles. The formalizations of these constraints are presented as well as the results of using a constraint programming solver to find the optimal schedule.



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## Paper 66

# Adaptive Spatial Sensing Using a Multi Camera System

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**Keywords:** image processing, spatial sensing, spatial navigation, depth map

Machine vision is not necessarily a challenge nowadays, as there are a number of sophisticated and rather expensive target devices available on the market. However, cost-effective customized solutions are still in demand. The aim of our project is to develop a robust, simple and preferably real-time method, based on several cameras' images only, which is still capable of localising spatial objects and determining their shape with sufficient accuracy.

We plan to use four focusable cameras connected to a Raspberry miniPC. Each camera can provide information about a specific section of space, in which they can even perform a small panning in order to get the most accurate resolution.. By identifying sharp areas, we can make estimates of the position and extent of objects and surfaces at a given distance, and hence of certain properties of space. As with image processing problems in general, this can be a fairly computationally intensive process, so designing the hardware system is an important task to achieve the desired result. However, the exact task does not always require high resolution or accurate computation, so the bottleneck, real-time processing, seems achievable. By using different image processing techniques, such as frequency domain image processing tools, the processing time and computational power can be greatly reduced. A method that works as described would be suitable to support autonomous navigation of vehicles, e.g. drones, in an unknown environment.



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## Paper 67

# Hyperspectral Imaging Technique for Underwater Mineral Detection

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**Keywords:** underwater, robotics, mineral, hyperspectral, multispectral

This article describes the progressive development of a specialised hyperspectral imaging system tailored for effective mineral detection and identification in underwater environments. Extending an existing technology, the focus is on enhancing the light source, optimising its distribution and refining the spectral composition to significantly improve mineral identification capabilities. Cutting-edge methods are used to effectively modulate and distribute the light, overcoming the challenges of underwater conditions and paving the way for breakthroughs in marine mineral exploration and resource evaluation. The study thoroughly details the methodology, experimental setups and results of the improved light source, providing compelling evidence of its potential to revolutionise underwater mineral detection technologies. Looking to the future, this research sets the stage for further advances and innovations in multispectral imaging, leading to a more comprehensive understanding of underwater mineralogy and its implications for various scientific and industrial fields.





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## Paper 68

# The Determination of the Line of Interest in a Line Scan Camera-based Measurement System

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**Keywords:** machine vision, line scan camera, statistical image processing, video generation

Line scan cameras are already used in many areas of industry, as they provide a suitable tool for both product inspection placed above conveyor belts and quality inspection of bulk materials. When using these devices in a traditional way, an important input parameter of the measurement system is the speed of the moving objects under examination since the sampling frequency of the camera must be tuned to this value. At the University of Miskolc, a measurement system was implemented for determining the speed of high-speed rotating parts using a line scan camera. In this case, therefore, moving away from the traditional way of use, the speed of the examined object is not an input parameter, but the characteristic to be determined. During the research, rotating, cylindrical parts whose mantle contains periodic patterns (such as the teeth of a gear) were examined. A pivotal point in the effectiveness of the measurement is whether the measurement system finds the appropriate measurement points in the image composed of rows of pixels. The measurement algorithm has already been proven on the simplest components, gears. However, it is questionable how the selection process changes if the examined component contains features with a different pattern. To investigate this, CAD models were designed that contain the features to be investigated, and a video generator application that can simulate the movement of 3D objects was implemented. This paper is intended to present this development process and the effectiveness of the measurement algorithm for the selection of the appropriate line of interest.



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## Paper 69

# Implementation of Heating Control for a Family House Using Wago PFC200 Controller and IoT Temperature Transmitters

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*Institute of Automation and Infocommunication, University of Miskolc, Hungary*

**Keywords:** MQTT, NodeRed, Wago, PFC200, HVAC, MSSQL, IoT

Control of HVAC systems is a typical application for PLCs in industrial or larger facility operations. In such cases, the control - and the necessary electrical infrastructure - is already integrated into the building during the design phase, so that it is sufficient to install the transmitters and the controller in the designated locations during the construction phase, and there is usually no further infrastructure work required apart from the set-up.

The situation is different, if a control system is installed in a family house, where it is often not possible to install new wiring and communication cables. There are also aesthetic requirements regarding the appearance and positioning of the devices and transmitters to be installed. Therefore, in my study, I used a solution that combines IoT temperature transmitters, which are nowadays easily and cheaply available, with a robust WAGO PFC200 controller, which is widely used in the industry. In my study, I cover the details of the MQTT, NodeRed and IEC-61131 standard PLC program, their wide range of applications and the difficulties of their coordination. The measurement results are stored in a MSSQL database, which provides access at a reasonable speed and wide usability for evaluations.



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## Paper 70

# Intelligent Computational Method for Temperature Distribution Analysis

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*Institute of Automation and Infocommunication, University of Miskolc, Hungary*

**Keywords:** intelligent calculation method, temperature distribution, modelling, IDW, validation of modelling data

In the case of monitoring and regulation of industrial processes, one of the main tasks is to produce a sufficient number and accurate data based on the measurement of the physical quantities of the process in order to make appropriate decisions. However, in many cases, knowledge of the distribution of a given physical quantity (such as temperature) is only limited or not available at all. In this case, temperature distribution modeling can be a solution.

The aim of the research is to find a modeling method that can be used in cases where the measurement of the distribution is not technologically possible or is only available to a very limited extent. Another goal of this paper is to show how to perform temperature distribution modeling using intelligent calculation methods, compared to a modeling method that uses traditional calculation formulas for modeling.

The paper also performs the modeling using the IDW (Inverse Distance Weighting) method, and then compares its results with temperature distribution modeling based on a new intelligent calculation method. The presentation of the new intelligent method makes it possible to estimate the data of the modeled temperature distribution based on the well-proven measurement points. The paper compares the results measured by the two models, revealing the application possibilities, advantages and limitations of the models. In modeling, it is always expected to find a solution to check the modeled data, which in this case means solving another problem, since only a limited amount of data is available for modeling. The research described in the article also answers this question and points the way to the possibilities of modeling development. This is the case of electronic product manufacturing, when PCB temperature distribution can not be measured exactly. The paper will present the comparison of real data with the modeling results.



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## Paper 71

# Analytical Examination of PI Control Variation during PLC CPU Replacement

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**Keywords:** PLC replacement, PLC, PI-control, DCS, Wago

In industry, PLC (Programmable Logic Controller)-based control and DCS(Distributed Control System)-based process control are used for automation and PI, PID-control. These controllers may fail or become obsolete for some reason, and therefore the product is no longer supported, so they must be replaced. This phenomenon results in many problems, such as unexpected programming costs, increased maintenance time and loss of energy efficiency. The article examines a case where only the CPU (Central Processing Unit) module of the PLC is replaced in a PI control loop operated by a PLC. The purpose of the study is to reveal which PI control quality and operational deviations can be observed using analytical and statistical methods. In the experiment, we replace a Wago PFC 100 750-8101 first generation CPU with a Wago PFC 200 750-8212 second generation CPU. It is important to note that the I/O cards are not interchangeable and are compatible with both controllers. The test uses a digital parallel generic PI algorithm, which is compared to the operation of the PI algorithm provided by the manufacturer.



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## Paper 72

# A Dashboard for the Comprehension of Move Semantics in C++ Source Code

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**Keywords:** C++ programming language, code comprehension, static analysis, move semantics, Microsoft Monaco

The move semantics of C++ increase the performance and improves the memory management and resource allocation of the code. However, many difficulties have appeared regarding this approach and subtle misuses can be executed based on this modern element of the C++. We created and implemented a static analysis-based approach that detects smells related to the move semantics, but it has limitations, for instance, it does not handle cross translation units. In this paper, we present our improvements for making the tool more convenient. These improvements cover the support of cross translation unit-based static analysis and a modern dashboard implementation which shows the problems project-wise in the Microsoft Monaco web-based integrated development environment (IDE). The static analysis solution takes advantage of the Clang compiler. We present how our code comprehension approach helps the programmers.



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## Paper 73

# Construction and Recognition Research of the Feature Model for Multi-Identity Spammer on Bilibili

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*Capital Normal University, China*

**Keywords:** multi-identity spammer, Bilibili, classifier, multi-feature fusion

With the development of the Internet, the phenomenon of spammers has gradually invaded Bilibili, which is primarily composed of young users and poses a significant threat to the intellectual development of young users. Moreover, with the increasing sophistication of spammers, a new type of spammer has emerged, known as the "multi-identity spammer." Therefore, it is necessary to explore the characteristics and research methods specific to this new type of spammer.

[Methods] In this study, Bilibili comments were selected as the research subject. A new spammer feature model was proposed by selecting traditional user features and exploring new spammer features, such as video features and comment similarity, based on the combination of time and text similarity. Finally, four algorithms, including Random Forest, were employed to construct classification models to verify the effectiveness of the Bilibili multi-identity spammer feature model.

[Results] The experimental results demonstrated that the recognition performance of the traditional water army feature model was generally poor, indicating that traditional spammer identification methods are no longer suitable for multi-identity spammers. In contrast, the Bilibili multi-identity spammer feature model exhibited significant advantages in various performance indicators. Particularly, the model utilizing the Random Forest algorithm achieved the best recognition performance. Therefore, the proposed feature model and new features in this study provide new insights and methods for identifying multi-identity spammers.



**Other engineering fields**







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## Paper 74

# Numerical Investigation of Generated Turbulence Flow in Different Types of Corrugation Channel

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**Keywords:** Ansys Fluent, corrugations channels, turbulent flow, k-epsilon, vortex generators

This numerical investigation is about turbulent flow through different types of corrugation channels in 2D aim to heat transfer enhancement. The increase in surface area gives us greater heat transfer at the same time as it leads to a pressure drop for that we will calculate performance coefficient which shows if our changes are gain more heat transfer then what it looses in friction. This way is to get as much heat exchange between the fluid and channel as possible. Vortex generators are used to manipulate and control the behavior of fluid flow, the role of the vortex generators is to eliminate the vortex around the walls of the channel, which increases the Nusselt number. The Nusselt number, friction factor, and overall performance coefficient for the configurations are compared at various Reynolds numbers (5000-17500). The Navier-Stokes (NS) equations are fundamental in fluid dynamics, describing the motion of viscous fluids, while the k-epsilon model is a widely used turbulence model that simulates turbulence in fluid flows by solving two additional equations for turbulent kinetic energy (k) and its dissipation rate (epsilon). This simulation was discretized and solved using the Ansys-Fluent commercial software based on the finite volume method. The results will be presented and discussed in detail.



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## Paper 75

# The Effect of Mixing Hydrogen Gas with Natural Gas on the Heating of Gas Storage Gas Equipment

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**Keywords:** natural gas, hydrogen, combustion, green energy

Both in the case of a fuel-poor as well as a fuel-rich mixture, it may happen that the flame goes out without any external influence. In the case of a mixture that is too lean, there are not enough fuel molecules to provide the energy required for combustion. The relationship between the flame propagation speed and the inlet flow rate determines whether the flame is stable. If the outflow velocity is lower than the flame propagation velocity, the flame will be unstable and backburn will potentially occur. In practice, in the case of household appliances, this can be a problem if the density of the feed gas decreases due to an added component (e.g. hydrogen), but at the same time the flame propagation speed component also increases, and after a certain ratio the magnitude of the flame propagation speed exceeds the outflow speed.

Mixing hydrogen gas into natural gas seems like a good solution due to the flexibility of the energy carrier, but for its wide application, it is essential to carry out the appropriate combustion technology measurements. Such an experience is, for example, that we verify with calculation and measurement at what percentage of hydrogen the backburning occurs. Another question is, if the density of the gas mixture decreases compared to pure natural gas, and thus the flow rate increases, then the range of the Wobbe number (calorific value flowed through a given cross-section in a unit of time) valid in the territory of the European Union will be maintained until the addition of a percentage of hydrogen. According to our measurements and experience, hydrogen with a lower calorific value reduces the total calorific value by up to one percent, which is not even compensated by the increased volume flow caused by the increased speed. However, this ratio reverses at high hydrogen percentages.

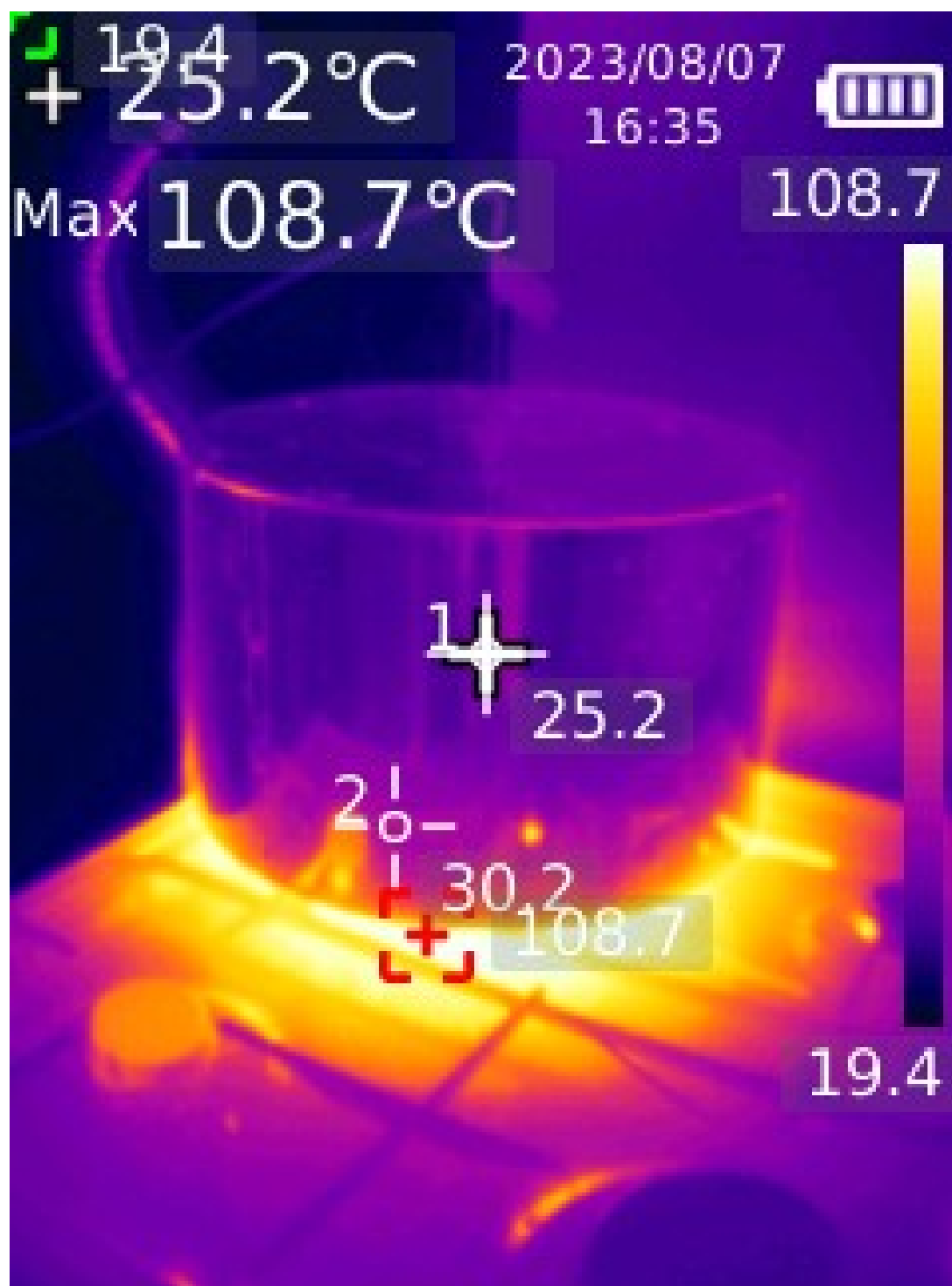


Figure 75.1: Thermal camera recording in the flame of a gas stove



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## Paper 76

# Comparative Analysis of the Machinability of Thermally Sprayed Cylinder Coatings Made from Base Powders of Different Producers

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**Keywords:** thermally sprayed coatings, machining, cylinder liner, atmospheric plasma spraying, wear resistant coating, oxidation

To reduce fuel consumption - and thus emissions - atmospheric plasma spraying of cylinder bores are widely used in the production of today's modern internal combustion engines. Since the coating process is carried out under atmospheric conditions, large-scale oxidation of the molten metal is unavoidable during the technological process. These developing oxide compounds mainly influence the honing process during the post-coating machining.

The research aims at analysing the difference between two cylinder coatings formed on the crankcase using base powders from two different suppliers, namely Oerlikon and Womet.

Results:

- XRD and chemical composition analyses showed similar coatings. However, the iron-oxide content of the Oerlikon coating was higher (43,5%) compared to that of the Womet coating (29,6%) due to the Si content being 0,41% and 0,87% in the Oerlikon and Womet base powders, respectively.
- SEM investigations revealed slag-like inclusions within both coatings, from which the Womet coating had a higher amount due to its higher silicon content.
- The average hardness of the Oerlikon coating was 313HV, while that of the Womet coating was 289HV due to higher iron oxide content in Oerlikon coatings.
- Hardness measurements simultaneously revealed a higher scattering of hardness values in the case of the Womet coating (135HV vs. 100HV), which is explained by the higher amount of slag-like inclusions.
- Profilometry analyses showed  $R_a = 13.6 \mu\text{m}$  surface roughness for the Womet coating compared to  $10.8 \mu\text{m}$  for the Oerlikon coating. The spatial material ratios are 0.6% and 1.8% for Womet and Oerlikon coatings, respectively. This phenomenon comes from the fouling of nozzles during coating with Womet caused by the lower melting temperature of Womet powder.

Based on the obtained results the application of the Oerlikon powder in manufacturing cylinder wall coatings is recommended for serial production compared to Womet powder from the point of view of manufacturing time, tool cost and application properties of the coating.



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## Paper 77

# Tube-Fin Contact Material Assessment in Heat Exchangers

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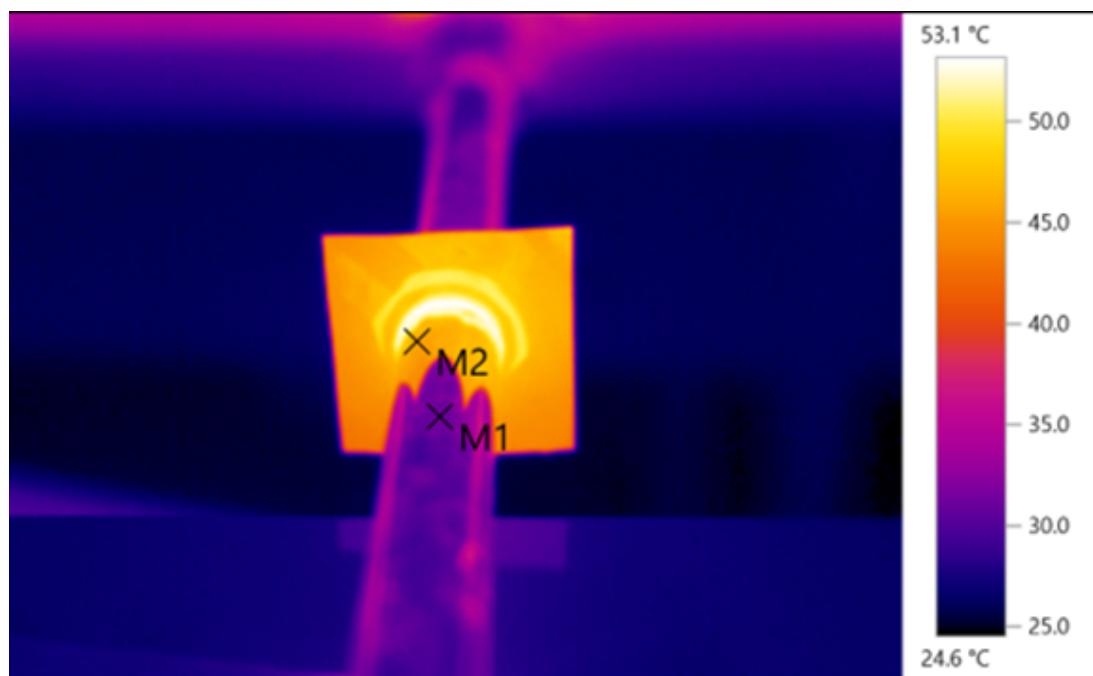
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**Keywords:** heat exchanger, finned-tube, contact materials, thermal conductivity, soldering, brazing, adhesives, thermal resistance, measurement challenges, thermal imaging

In an effort to improve heat exchangers in operational environments, we conducted experiments on finned tube heat exchangers, focusing on reducing the heat conductivity resistance at the contact between the fin and the tube. Various contact materials, such as solders and adhesives were investigated. For the experiments, tubes were cleaned with acetone and ground with high grit SiC paper. Several methods of establishing contact were tested, including PB gas torch brazing and soldering in an industrial electric oven. Our measurements indicated that reflective surfaces posed challenges during thermographic measurements; however, this issue was resolvable by applying a thin layer of paint, with its emissivity factor determined to be  $\varepsilon = 0.95$  [-]. Our studies revealed that gas torch brazing was successful while soldering attempts failed. Further research is necessary for interpreting the results and advancing the technology. Because of the thermal measurement difficulties, a need for an independent analysis arose. Thus, the heat transfer of the contact materials was assessed using finite element analysis. The thermal camera measurements did not give valuable results; thus, this methodology was proven insufficient. The results from the finite element analysis showed that all the inspected contact materials give better heat transfer than not using a contact material.





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## Paper 78

# The Effect of Physical Parameters with Intensive Fluctuation on Thermal Comfort

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**Keywords:** thermal comfort, comfort manikin, air velocity, human subject measurement

The paper introduces a thermal comfort research. In the research, we examine the effect of thermal inertia on the predicted mean vote (PMV). During the research, we compare the results measured with a thermal comfort measuring station and a thermal manikin with subjective evaluation results, which we measured with the involvement of human subjects. The expected thermal sensation is determined by the PMV-PPD method specified in the ISO 7730 standard. The methodology was determined for a constant, stationary, source-free case during the procedure specified in the standard. However, in everyday practice, we often encounter cases where some physical parameter is not constant, not stabilized. This can be, for example, a building operating with an air conditioning system. We consider the effect of the intensive fluctuation of air velocity by simply averaging the measurement data, which greatly simplifies the problem. The aim of the research is to create a calculation procedure that evaluates the effect of intensively changing physical parameters in a complex way. For the measurement, we used a universal thermal comfort measuring station (TESTO 400) and a Danish-made thermal manikin, custom-made by PT-Teknik. The measurement was performed according to ISO 7726. The subjective measurements were made with the involvement of subjects, and a questionnaire survey was conducted during the measurement, based on the methodology specified in ISO 10551. The questionnaire was prepared in Hungarian and English after several rounds of consultation, and consisted of 13 questions, mainly related to thermal sensation and air velocity, in accordance with GDPR data protection requirements. The research was carried out at the Laboratory of Building Services and Facility Engineering Department of the Faculty of Engineering and Information Technology of the University of Pécs.





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## Paper 79

# The Relationship Between PMV-PPD and Work Performance in an Office Environment

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**Keywords:** thermal comfort, literatura review, PMV-PPD, air temperature

The presentation examines the relationship between temperature and office work performance, based on the PMV-PPD theory. The paper presents the results of several previous studies that measured the effect of temperature on cognitive and typing tasks, simulating office work, using different methods and locations. For this purpose, several studies have been used by R. Kosonen and F. Tan, by D. P. Wyon, by J. v. Hoof, by Tsinghua University in Beijing, articles by Hosei University in Japan, and a joint publication by Queensland and Sydney universities in Australia on the topic. The individual papers approached the problem from different directions, under different conditions, using different methods, examining different parameters. The aim of the paper is to help to optimize the office environment and energy efficiency by examining and comparing these research papers.



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## Paper 80

### Thermal Testing of Heatable Glazing

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**Keywords:** thermal comfort, heatable glass, thermal manikin, indoor air temperature, glass surface temperature

In enclosed spaces, the most important factors influencing thermal comfort are air temperature and the surface temperature of the boundary structures. The surface temperature of glazed structures can be up to 3-4°C lower than the room air temperature in winter. In rooms with large glass surfaces, this lower surface temperature can result in radiant asymmetry and thus discomfort. Low surface temperatures are usually corrected by raising the air temperature. However, raising the air temperature increases heat loss through all boundary structures. The primary objective of the measurements is to investigate how thermal comfort can be increased economically by increasing the surface temperature of the glass. The surface temperature of the glass was increased using an electrically heated window. During the series of measurements, the temperature of the external and internal (heated) surfaces of the glazing and the electric heating power were recorded. The heat radiation on both sides of the glazing was measured with a thermal manikin.

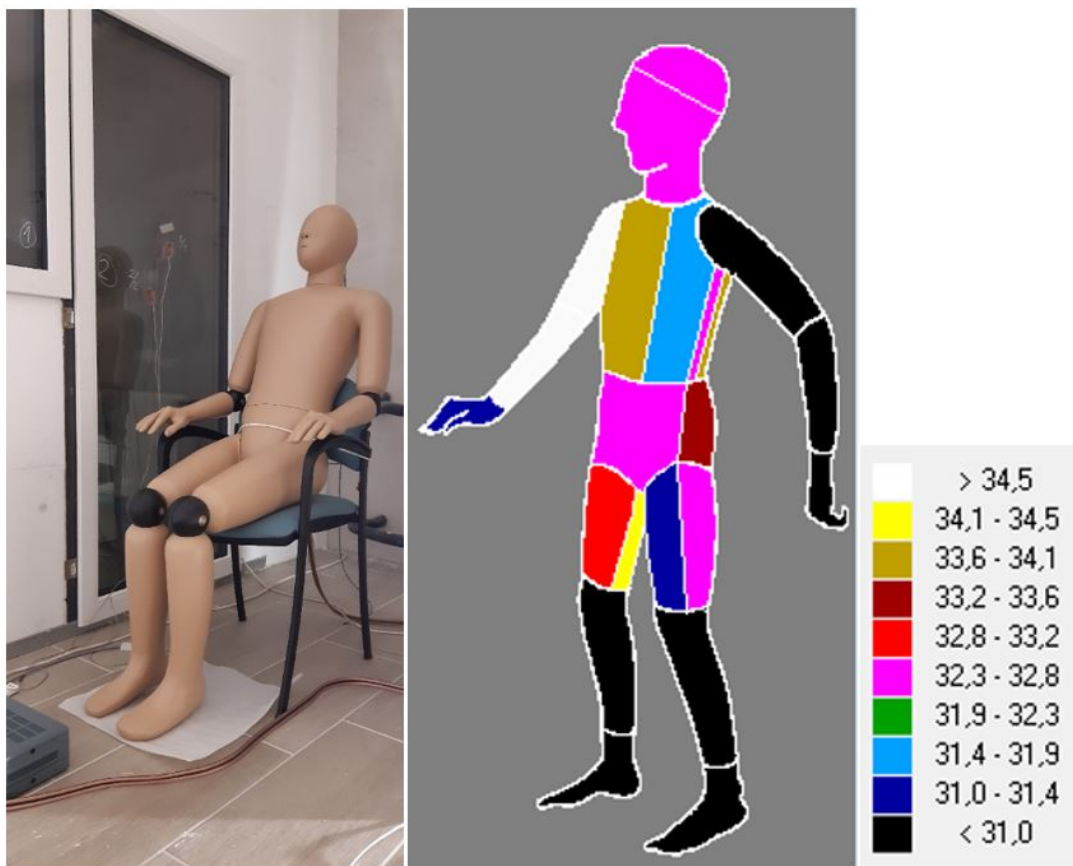


Figure 80.1: Thermal manikin in front of the heatable glass



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## Paper 81

# Investigation of the Surface Oxide Layer and Pitting Corrosion Susceptibility of an Aluminium Alloy Produced by Additive Technology Using Electrochemical Methods

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**Keywords:** aluminium, additive manufacturing, corrosion, electro chemistry, pitting

The excellent corrosion properties of aluminium and its alloys are due to the passive layer formed on their surface. I investigated the corrosion resistance of the passive layer on samples prepared by an additive manufacturing process based on the CMT process. During my tests, I removed the passivation layer by mechanical grinding and investigated its regeneration and condition by different electrochemical techniques. The presence of chloride ions is one of the main causes of pitting corrosion, so I used an aqueous solution of 0.1 M KCl for my tests. In the electrochemical cell used for the study, I used a saturated calomel electrode (SCE) as the working electrode (WE), a reference electrode (RE) as the reference electrode and a platinum electrode (CE) as the counter electrode..

The corrosion potential ( $E_{corr}$ ) is a good indicator of the corrosion susceptibility of a given metal or alloy and, for metals which tend to passivate, shows the condition of the passive layer. It can be measured using the open circuit potential-time (OCP) measurement, where the potential is measured relative to the reference electrode. The monitoring of its variation allows the passivation process to be monitored. The stability of the corrosion potential indicates the stability of the tested corrosion system.

An accurate knowledge of  $E_{corr}$  is necessary for the application of polarisation-based testing techniques. Since the reduction and oxidation processes at the surface are in equilibrium at the corrosion potential, any polarisation is a strong influence on these processes. Measurement of the polarization resistance ( $R_p$ ) and Tafel extrapolation provide a means of accurately measuring the general corrosion rate, while cyclic potentiodynamic curves can be used to detect the tendency to pitting corrosion. In each case, the current between WE and CE is measured as a function of potential, the difference being in the scanning range and the way the results are plotted.



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## Paper 82

# A Novel Test Method for Analyzing the Scratching Behaviour of Polycrystalline Diamond Coatings

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**Keywords:** tribology, polycrystalline diamond (PCD) coatings, scratch test, surface roughness, coating adhesion

Polycrystalline diamonds (PCDs) are increasingly used in the industry as protective coatings. The tribological performance of these coatings highly depends on the technological process, affecting the microgeometry and structural characteristics of the coating. Investigations and optimization of these influencing factors are essential for increased efficiency for PCD-coated tools in manufacturing.

The investigated materials were polycrystalline diamond (PCD) coatings on steel substrates with different surface roughness. The research aims to analyze the correlation between the scratching behaviour and microgeometry of the coatings. Non-standard progressive loading scratch tests applying a steel ball stylus were performed on 5 samples with different roughness ( $R_a = 0.62 - 4.11 \mu\text{m}$ ). Morphological analysis of the scratch grooves and the worn surface of styluses was carried out using optical microscopy and 3D profilometry.

The most important conclusions are as follows:

- The applied novel scratch test method with a stainless steel ball stylus is applicable for characterizing the scratching behaviour of the tested PCD diamond coatings.
- The  $F=150\text{N}$  normal load did not cause delamination of coatings, i.e., a critical force is impossible to define due to the excellent adhesion of the coating to the substrate.
- The friction behaviour is roughness dependent: with an increasing  $R_a$  of coating, the coefficient of friction is decreasing.
- Scratch grooves on the rough surface of the tested PCD coatings are difficult to reveal by optical microscopy, but some indication of the termination of the coating integrity could be recognized.
- 3D profilometry is helpful in analyzing the tested coatings' surface topography and scratching behaviour.

The direction of the future work is defining the scratching energy from the scratch diagrams to provide a more reliable basis for comparing the scratch resistance of these coatings produced with different geometrical and structural characteristics.



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## Paper 83

# Hazardous Area Classification by Testing the Explosion Characteristics of Different Natural Gas Mixtures

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**Keywords:** hazardous area classification, explosive atmosphere, natural gas, ATEX

Natural gas contains high levels of methane, which accounts for approximately 95%. When considering hazardous area classification, the combustion and explosive properties of methane are commonly used, but in this study the explosive properties of different gas mixtures were investigated using laboratory equipment. Measurements were made to determine the lower explosive limit of real natural gas samples. The higher the inert content in natural gases, the higher the lower explosive limit. The measured values were used to determine the extent of the explosive zones as defined in the literature, and a sensitivity analysis was performed to observe the differences between the results.



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## Paper 84

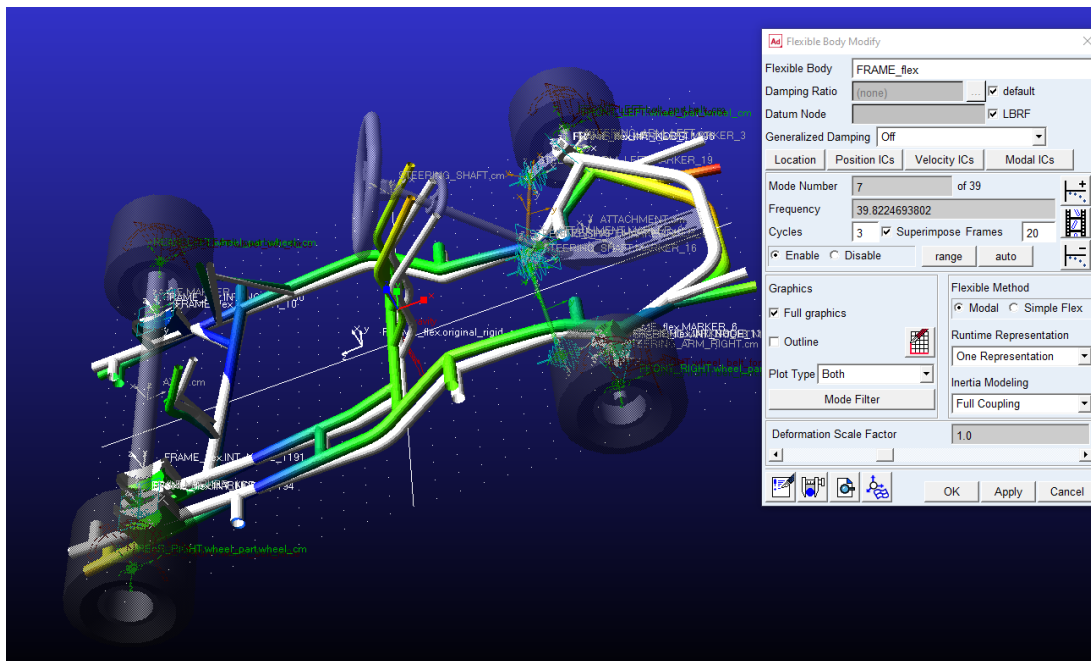
# Development of a Coupled Multibody Dynamics Model for Racing Go-Karts Considering Frame Flexibility

**K. Horváth, A. Zelei**

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**Keywords:** gokart, MBS, multibody, flexible multibody, FMBS, coupled multibody

Addressing simplicity, racing gokarts are devoid of suspensions and differential. Therefore, the driving dynamics is primarily influenced by the steering mechanism, tire characteristics frame geometry and especially by the frame stiffness. The frame stiffness affects the wheel bouncing and prevents tire skidding in the absence of a differential by lifting the inner rear wheel during turns. Our primary goal is the optimization and understanding of the dynamics of racing gokarts, which require a holistic approach and virtual testing methods. The initial steps towards optimization involved the identification of primary configuration parameters affecting ride dynamics, such as axle material, length, type of torsion bar, bumpers, floorboard, and even seat properties. This study employs a coupled rigid-flexible model in MSC ADAMS, validated by in-operation frame deformation measurements. All parts in the model are rigid except the frame and tires. The rigid parts and the tire model were developed in MSC Adams View, as the gokart model is not available in the Adams Car template library. The frame geometry was imported from CAD files based on homologation specifications. A finite element model of the frame was established and validated through experimental modal analysis and static stiffness tests. The eigenmodes from FEM analysis were conveyed to MSC Adams via Modal Neutral Files. The simulations integrate finite element analysis with multibody techniques for evaluating the dynamics of the gokart and the developed model is applicable for maneuver simulations, with paths manually constructed. Utilized as a virtual testing tool, this validated model assesses dynamic behavior of racing gokarts in diverse configurations. Such model development becomes especially challenging given the continuous evolution of gokart multibody models, driven by pressures on racing teams. Our work has not only provided a comprehensive framework for modeling but has also laid the foundation for further optimization in racing gokart designs







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