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Fundamental field: Engineering Sciences
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HABILITATION THESIS
– ABSTRACT –

Design of new buildings and energy retrofit of existing ones: contributions and perspectives

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The present habilitation thesis, entitled **"Design of New Buildings and Energy Retrofit of Existing Ones: Contributions and Perspectives",** summarizes the main scientific, professional, and academic achievements of the author from her doctoral thesis defence, titled "Contributions to the Optimization of the Thermo-Energetic Performance of New and Existing Buildings," on September 23, 2009, in the field of Civil Engineering and Installations, until the present.

The thesis is structured into three main parts:

- *Introduction,* providing an overview of the author's academic, professional, and scientific journey.
- *Scientific, professional, and academic achievements*, which succinctly present the research directions explored, such as obtaining environmentally friendly materials, addressing issues related to hygrothermal bridge evaluation and solving, developing catalogues with thermotechnical design parameters for architects, energy auditors, doctoral and master's students, and other specialists in the field. It also covers the evaluation of the thermal and energy performance of new and existing buildings through numerical calculations and non-invasive methods, the development of thermotechnical and energy calculation programs, the study of alternative energy source implementation to reduce building energy consumption, and the assessment of building thermal performance using current non-invasive methods (e.g., terrestrial, and aerial thermography).
- *Plans for career evolution and development*, presenting future research directions by identifying new opportunities and challenges within the author's expertise. It outlines the plans for developing her academic and scientific career and her involvement in institutional activities, exemplifying her potential contributions to the academic and professional community.

The conclusion of the habilitation thesis includes the references used throughout the thesis, the list of figures and tables in the work, and a list of the author's scientific publications.

The first part of the thesis (i.e., *Introduction*) summarizes the scientific profile of the candidate over the 18 years of her career, from the moment she became a doctoral student to the present, where she serves as an associate professor in the Department of Civil Engineering and Management (CCM). It briefly presents the four research projects she won, including 1 CNCSIS TD-type grant, 1 CNCSIS BD-type research scholarship, 1 postdoctoral scholarship PARTING, and an ongoing UEFISCDI PED-type project, numbered 714PED/2022, entitled " Optimisation and validation of a specialised software used for calculating the thermal performance of the building envelope components, developed based on aerial and terrestrial thermography method (Acronym: THERMOG)." Additionally, Dr. Moga has been a member of eleven other research grants/projects focused on the vast field of building energy efficiency. Moreover, she is also a member of nine other institutional projects focused on civil engineering, employee digital skills training, fostering a generation of entrepreneurs, university internationalization, and developing the European University of Technology EUt+.

Regarding research dissemination, the candidate has published over 130 scientific papers in ISI journals, ISI proceedings, BDI journals, BDI proceedings, non-indexed journals, and non-indexed proceedings. Her published articles have significantly impacted the national and international scientific community, totalling approximately 246 ISI citations (204 in journals and 38 in proceedings) and 112 BDI citations. Her Hirsch index as of July 2023 is 11

on Google Scholar (GS), 8 on Web of Science (WOS), and 8 on Scopus. The candidate has participated in over 50 prestigious international and national conferences. Her publications include six specialized books, five published by UTPRESS and one by Springer Tracts in Civil Engineering, and four books as a co-editor.

The research results obtained over the years have been awarded at various conferences and invention fairs. Furthermore, her participation in specialty conferences has been in various roles, including author, reviewer, scientific committee member, chairman, and keynote speaker. Additionally, she actively contributes to reviewing articles published in ISI and BDI journals.

It should be noted that the scientific significance of the conducted research and the manner of presenting the results have earned the author two additional awards: the "Best Speaker Award" - SGEM Vienna Green 2019 and the "Best Paper Award" - SGEM Vienna Green 2022.

Over the years, Dr. Moga has served as the scientific coordinator for doctoral and postdoctoral students in the Eugen Ionesco scholarships and other scholarships offered by the Francophonie University Agency in Building Physics and Building Energetics. With the same expertise, she has also coordinated 57 students within the Research Collective in Physics and Protection of Buildings (RCPPB), of which she has been the coordinator since 2010, winning various awards at scientific student communication sessions.

The author has been a member of 7 thesis defence committees, 6 at UTCN and 1 at UPT, as well as a member of evaluation committees for research papers of doctoral students within the CCM and MECON departments of the Faculty of Civil Engineering, UTCN.

All this extensive research activity culminated in the author's acceptance in 2018 as a member of CNATDCU, within the "Civil Engineering and Management" commission, where she served until 2020.

Her teaching activity has focused on imparting fundamental and advanced knowledge in the field of Civil Engineering, Buildings, Building Physics, and Building Energetics, as well as in the domain of Academic Ethics, by teaching disciplines in the Faculty of Civil Engineering, Faculty of Architecture and Urban Planning, Faculty of Building Services, and Faculty of Automotive, Mechatronics, and Mechanics. She has supervised over 61 bachelor theses and 51 master's theses, as well as theses for the first-degree qualification exams of pre-university teaching staff. Additionally, she is the initiator and coordinator of the Green Buildings master's program and the institutional event held annually, known as the "International School UTCN."

To acquire and assimilate current knowledge and notions in her field of interest, the author has participated in specialized courses annually at renowned universities in Romania and abroad.

Dr. Moga coordinates five postgraduate courses within the DECIDFR (UTCN) department and lectures in several courses within this department, some of which are conducted in other faculties at UTCN. She has also lectured at national professional associations, delivering thematic presentations. Over the years, she has been an active member in international professional associations such as ISIAQ, IABP, IBPSA-USA, RILEM, and at the national level in OPSEC. Since 2018, she has been the president of the professional association OPSEC.

In parallel, Dr. Moga has been professionally certified as an Energy Auditor for Buildings (grade I), Project Verifier, and Technical Expert in energy savings through appropriate thermal insulation of constructions and installations for all domains. She is a

certified European Energy Manager, international passive house designer, and building assessor on BREEAM INC 2013 system.

All these certifications have led to the expansion of the project portfolio carried out with third parties, resulting in catalogues with design parameters for students, doctoral students, designers, energy auditors for buildings, and other specialists interested in this field. From the extensive portfolio of projects she has coordinated or been a member of. Her participation from 2023 to the present is worth mentioning as an expert in energy efficiency and sustainability in the EIB Project Advisory Support Team for Lot 3 - Healthcare "Construction of 3 Regional Emergency Hospitals (REHs) in Romania."

The presentation of the author's professional evolution concludes with an indication of the roles she has had and currently holds within ministries and standardization associations. Dr. Moga is a member of the CTS E and CTS no. 1-MDLPA committees and the CT 281 and CT 113 committees at ASRO. Additionally, she represents UTCN in the Coordination Committee for Monitoring the Implementation of the National Long-Term Renovation Strategy within the Department for Sustainable Development, Romanian Government.

The first part ends with exemplifying the fields and research directions addressed, highlighting specific areas where research activities were conducted and her contributions to developing the Civil Engineering and Installations domain. Furthermore, it emphasizes the level at which the minimum standards required for obtaining the authorization certificate are met.

The second part of the thesis (i.e., *Scientific, professional, and academic achievements*) covers a series of research directions and activities undertaken by the author, focusing on the broad domain of building energetics.

This chapter explores research on the development of thermal insulation materials with low environmental impact, along with studies on nano-thermal insulating materials and the development of materials with structural and thermal insulation roles made from biosourced sources. It is worth mentioning that these research endeavours were conducted in collaboration with doctoral students from the CCM department and through fruitful partnerships with doctoral and postdoctoral students from Université Mohammed 1er in Morocco.

The second part continues with the presentation of research conducted to assess the thermal performance of various types of buildings with wooden, metal, masonry, concrete structures, and large-prefabricated panels. Finally, emphasis is placed on research conducted to evaluate the thermal performance of glazed surfaces. The chapter highlights other research in the vast field of building performance within the context of sustainability, which the author has studied and addressed collaboratively. It also includes several examples of determining thermal performance through 2D and 3D simulations to assess the overall thermal performance of the building ensemble together with the surrounding land on which it is placed.

Next, the research on integrating alternative energy sources in buildings is presented, focusing on solar thermal energy and its production and storage efficiency.

The final section provides information on research conducted to evaluate the thermal performance of building envelopes using non-invasive thermographic measurement methods. The chapter showcases project 714PED/2022 research, which aims to optimize an algorithm and calculation methodology that utilizes infrared, terrestrial, and aerial thermography for real-time evaluation of the building envelope's thermal performance. It also presents information on the algorithms developed for pre- and post-processing the data collected from the field using the THERMOG calculation program. The development of this project is closely

linked to the identified market need for a professional real-time assessment tool for the thermal performance of a building's envelope.

The last part of the habilitation thesis (i.e., *Plans for career evolution and development*) begins with the presentation of future research directions that the author intends to pursue, including: further development of modelling and simulation programs for determining the energy performance of buildings, identifying efficient solutions for zero-emission buildings (ZEB), developing dynamic materials for ZEBs, designing building envelopes for low energy consumption, evaluating thermal bridges in ZEBs, using machine learning techniques to optimize energy-efficient building design, employing computer vision techniques for constructing 3D thermal models of buildings, utilizing artificial intelligence algorithms for segmentation, identification, and classification of thermal and/or structural anomalies in buildings, developing databases and online tools for assessing the thermal performance of buildings, and continuing research activities in collaboration with doctoral students, members of RCPPB, and other interested collaborators on these research topics. These research efforts will contribute to advancing energy efficiency in construction and achieving sustainability and energy efficiency goals at the European level.

Regarding career development plans in teaching, the author aims to coordinate diverse academic activities, update course content, and develop international collaborations, with the objectives of guiding students in research and scientific student competitions and continuously developing their own knowledge and skills.

Dr. Moga aims to continue participating in national and international research project competitions, expand research activities through interdisciplinary collaborations, and develop an online platform with relevant databases for building energy efficiency. She plans to continue publishing papers in specialized journals and actively and annually participate in relevant conferences within her expertise. Additionally, she intends to organize an annual conference dedicated to building energetics and support the revitalization of the "Acta Technica Napocensis: Civil Engineering & Architecture" journal of the Faculty of Construction, UTCN, while persistently working to increase its visibility and prestige.

The author will continue to actively engage in committees for the completion of undergraduate and master's studies, admission committees for the master's program, and coordinate the Erasmus+ program, focusing on developing student and academic staff mobilities. Furthermore, she will continue activities within the EUt+ project and emphasize attracting lecturers to the events of the UTCN International School within the EUt+ consortium. Dr. Moga wishes to remain an active member of the faculty council and the UTCN senate and continue her efforts in promoting the educational offerings, internationalization of the university, and research infrastructure development, to support the Technical University of Cluj-Napoca in achieving top positions in the global university hierarchy.

In conclusion, this habilitation thesis highlights the author's research in the field of civil engineering, with a focus on building energy compliance, showcasing her potential to supervise future doctoral candidates in the field of Civil Engineering and Installations and contribute to the development of knowledge and innovations in this domain.