

WG1: Furniture and domestic habitat
WG Lead: Jake Kaner (NTU)

State of the Art for this working group is represented by a range of literature, designs, patents, websites, conferences and other output types, as provided below.

Conferences and conference papers

SISTEMA INTELIGENTE DE ALERTA Y MONITORIZACIÓN DE PERSONAS MAYORES Y/O DEPENDIENTES QUE VIVEN SOLAS (PROYECTO "LUCÍA"). IV CONGRESO CIUDADES INTELIGENTES. - Félix Fariña Rodríguez, Consejero con Delegación Especial TIC y Sociedad de la Información, Cabildo de Tenerife.

- David Pérez Rodríguez, Director Técnico del Proyecto Tenerife Smart Island, Cabildo Insular de Tenerife Madrid, 30-31 Mayo 2018 (<https://www.congreso-ciudades-inteligentes.es/>)

The objective of the "Lucia" project is to sensorize homes of elderly people and / or dependents who live alone so that a system based on artificial intelligence detects patterns of behavior. The aim is to create an AI system that is constantly learning and is capable of analyzing the behavior patterns of its users, carrying out warning actions when significant alterations of these patterns are detected. Depending on the level of the alert they will be transferred to specialized personnel or to relatives and / or tutors. In 2017, the Island Council of Tenerife carried out with its own means a proof of concept (PoC) of the "Lucia" project, through which the homes of three elderly people living alone were sensed, obtaining positive results that encourage us to continue advancing in their developing.

BUILDING THE GREEN-SMART WAY: EXPLORING CONDITIONS FOR GREEN AND SMART FURNITURE MANUFACTURING FOR PEOPLE IN THE THIRD AGE. 7th Annual EuroMed Conference of the EuroMed Academy of Business. Trigkas Marios et al.

The present paper discusses some of the findings of an ongoing "Green & Smart Furniture" (GSF) research project. It actually focuses on third-age consumers' behavior and interest in purchasing smart and eco-friendly wooden furniture. The research reveals the critical elements for a successful design and production of GSF products that will enhance both needs and expectations of the consumers. Thus, 399 specially constructed questionnaires were gathered during 2013, which were further elaborated and statistically analyzed with SPSS ver 17.0. Results are quite encouraging for the enterprises that would decide to design and produce smart and eco-friendly wooden products. Consumers show a significant interest in purchasing GSF at a percentage of 70%. They are willing to pay an extra amount of 9% in average than regular prices of conventional furniture. The most important factors in purchasing GSF have been found to be price, quality, functionality, safety and ergonomics, as well as the type of raw materials.

Bioclimatic design of a residential complex for the elderly. International Conference "Passive and Low Energy Cooling 737 for the Built Environment", V Simantria et al. May 2005, Santorini, Greece.

Traditionally, a home for the elderly aimed exclusively at the accommodation and care of people of the 3rd and 4th age. In a modern and continuously evolving society, how this can remain stagnant? This design, which was presented as a diploma design work at the Architecture Department of the University of Patras, constitutes a new idea, a revision and redefinition of the meaning of a 'home for the elderly'. A strong emphasis is placed on modern way of life and how this can influence the needs of old people and be influenced by them. The basic concept is based on an open plan system, with bioclimatic features. The aim is to create a secure, pleasant and modern environment fulfilling the requirements of a contemporary building while keeping some elements of the past so as to achieve a balanced aesthetic result.

Design and Ergonomics of Monitoring System for Elderly. 5th International Conference, DHM 2014. Andreoni et al. Springer International Publishing Switzerland.

Innovation in Furniture Combining Ecology and ICT: The Green and Smart Furniture Research Project (2015) I Papadopoulos et al. Proceedings of 7th Annual American Business Research Conference ISBN: 978-1-922069-79-5

Integration of Smart Home Technologies in a Health Monitoring System for the Elderly (2017) A. Arceleus et al. 21st International Conference on Advanced Information Networking and Applications Workshops. 0-7695-2847-3/07

Intelligent Furniture Design in the Elderly Based on the Cognitive Situation (2017) X. Lu et al. MATEC Web of Conferences. 10.1051/mateconf/2017104030

[Refinement of temperature sensing yarns.](#) (2018) LUGODA, P., HUGHES-RILEY, T., OLIVEIRA, C., MORRIS, R. and DIAS, T. *Fibers*, 6 (3): 46. ISSN 2079-6439

Designs and patents

Many designs and patents exist that provide solutions for the elderly in the domestic habitat and the working environment,

SISTEMA DE AYUDA Y SEGURIDAD, PARA EL CUIDADO DE PERSONAS MAYORES, ENFERMOS, NIÑOS Y BEBES. SPANISH OFFICE OF PATENTS AND TRADE MARKS (OFICINA ESPAÑOLA DE PATENTES Y MARCAS - OEPM). PALACIOS DE LA OLLA, Ricardo (ES).

Application number: U201800508

Submission date: 06/06/2018

Publication date: 16/10/2018

Publication number: [ES1218994](#)

The present invention refers to a support and safety system and method, for the care of the elderly, sick, children and babies. It can be used universally in a variety of beds, cradles, chairs and the like, located in homes, hospitals, nursing homes, residences and similar places.

The system and method detect when the user has gotten out of bed, cradle, chair or similar and activate a courtesy lighting lamp to avoid falls due to lack of vision. Likewise, it allows to activate a plurality of alarms to warn caregivers and/or relatives when the user is detected to have been up for a long time. In this way, if the user falls when getting up and spends too much time away from the bed, crib, chair or similar, their relatives or caregivers receive a warning signal to go for it and avoid greater problems.

SISTEMA DE MONITORIZACIÓN DEL ESTADO DE UN SUJETO. MAESTRE FERRIZ, Rafael*; BLEDA TOMÁS, Andrés Lorenzo*; SANTA CARVAJAL, Guadalupe*; PELLICER FERNANDEZ, Soledad*; GARCIA ORTEGA, Sergio*.

SPANISH OFFICE OF PATENTS AND TRADE MARKS (OFICINA ESPAÑOLA DE PATENTES Y MARCAS - OEPM)

Application number: P201331727

Submission date: 27.11.2013

Publication date: 09.12.2015

Publication number: [ES2536826](#) B1

A system for monitoring the state of a subject, specifically designed for installation in homes or rooms etc., comprising items of furniture with at least one built-in sensor capable of measuring a physical parameter of the subject; a processing unit linked to a piece of software for receiving an electrical signal from at least said sensor and a data communication module for wirelessly transmitting the parameters obtained by at least said sensor. As such, this processing unit generates

a signal when it detects an anomalous value or pattern of behaviour linked to at least one parameter received by at least one sensor.

Learned Societies

There are many sources of information that are relevant to this working group and these include,

<https://www.designresearchsociety.org/cpages/wellbeing-happiness-sig>

The Design Research Society provides a special interest group on Wellbeing which includes a network of researchers to engage and discuss design related topics. This group positions itself as a community whereby those with expertise in design, psychology, engineering, architecture, human factors, technology development, HCI, healthcare and other disciplines can come together to nourish the interdisciplinary of the domain.

Literature

Current literature presenting State of the Art products and services as well as research and theoretical developments is listed here and represents contributions from many EU states,

State of Art Senior and Habitat (2018) Valerie Gourves and Clement Grange, Report FCBA Institute, France

This report covers 27 studies, experiments and product developments through the work of the FCBA. These are listed below,

The importance of assessing the environment to determine the most suitable location for seniors' residences so as to adjust the supply to the needs. et Psychologie Neuropsychiatrie du Vieillissement, 16(1), 31-38, 2018. Pierre-Marie Chapon - University of Lyon System, Guillaume Petit - University of Lyon System, Kévin Phalippon - Efferve'sens, Amberieu-en-Bugey, France.

Seniors' residences must be located in areas that foster the well-being of both residents and staff. This study is unprecedented in France. It uses the multi-criteria decision-making method to classify the environmental targets in priority order, according to the importance they are given by the people living or working on the premises as related to their proximity to the residence. The results are then integrated into a mapping of areas in which the targets are geolocalized, thus highlighting the most suitable zones. The data collected from interviews and from the mapping vary from one residence to another. Nevertheless they all clearly point to the importance of a territorial approach before planning the building of such residences

Environment and Living Conditions of Older Home Owners Gérontologie et société, 2017/1 (vol. 39 / n° 152) S Renaut, J Ogg, A Chamahian, S Petite.

The aim of this paper is to present a general descriptive account of the environment and living conditions of home owners aged 55 years and above using data on the opinions of households in the French Housing Survey, 2013 (Enquête Logement 2013, Insee). Four groups of home owners are identified according to the degree of satisfaction expressed with the quality of their environment and housing: the first group (46%) are largely satisfied with the quality of their neighbourhood and housing (G1. High quality of environment and housing); the second group (35%) are satisfied with their environment but much less so with their housing (G2. Calmness and rusticity); in the third group (10%), the convenience of housing is mitigated by a low environmental quality (G3. Interior comfort, poor quality of environment); finally, the home owners in the fourth group (9%) are much less satisfied with their housing and their environment (G4. Deteriorated living conditions). The

intersection of the expressed opinions with resources reveal strong social inequalities between home owners: on the one hand, the higher social class households in Groups 1 and 3 and on the other hand, low incomes for the households of farmers, manual workers and employees in Groups 2 and 4. The paper concludes with a discussion on home adaptations for older home owners on lower incomes living in rural areas (G2) or in urban areas (G4).

The "Mono-Polar" Young Retirees and Reorganisation of Domestic Settings *Gérontologie et société*, 2017/1 (vol. 39 / n° 152). Melissa petit.

The transition to retirement can result in a new rapport with domestic space, as is particularly the case with the retirees in this study who were engaged in voluntary work or in work. Indeed, retirement deprives the individual of a public space outside of the home confines him to the private domestic sphere that he will progressively need to redefine. This article helps us to understand the evolution of refurbishments of domestic spaces at the time of retirement: what types of space younger retirees are deprived of? What spaces do they re-invest? What are the processes involved in the redistribution of spaces within the domestic setting, as well as with the exterior environment? We hypothesise that reorganisation of domestic spaces are influenced by reorganisation of lifestyle of recently retired people. Thus, in this paper two areas of activity are privileged: voluntary work and remunerated work of retired people, which can affect positively or negatively accommodation of domestic settings.

Choosing to Live in Sheltered Housing: Between Individual Trajectories and Public Policies. *Gérontologie et société*, 2017/1 (vol. 39 / n° 152). AB Simzac

This article proposes creating a connection between the residential process and public policies regarding collective housing such as sheltered housing. It examines the individual choices related to accessing collective housing for elderly people. This allows analysing the potential impacts of public policies regarding sheltered housing on elderly people's trajectories. After a short introduction of sheltered housing and related public policies, the article defines the reasons for joining these establishments and then the limits of that offer characterised by blockages of access. These elements are seen in the context of regulatory obligations regarding public policies on sheltered housing and the recent evolution of French legislation. The results are based on a collection of qualitative data gathered during a PhD research. The article is mainly based on interviews conducted with elderly people and managers in the establishments as well as providing an analysis of legal and operational documentation.

Déprise from the Prism of Intermediary Housing for the Elderly. *Gérontologie et société* 2018/1 (vol. 40 / n° 155). Laurent Nowik

For elderly people, residential mobility can trigger considerable consequences, especially if it happens in tandem with events linked to individual ageing. This can be it is observed through the process of moving into intermediary housing (service-apartments cum residences for senior citizens, sheltered housing accommodation and other forms) which often concern elderly people in a situation of *déprise*. Based on research amongst people living in intermediary housing (IH), this article locates the different reasons which account for this residential choice and argues that these forms of habitat enable re-securing these persons. Depending upon the reasons that propel older people to move into IH and the interplay with other variables such as health, forms of sociability, etc., it appears that individuals do not benefit in a similar way from the services which are proposed within the premises of these diverse properties, and that the reconstruction of one's home and sense of place identical to the former residence remains an incomplete process for a some of the older movers. These observations lead us to identify of the notion of a residential bifurcation. To summarize the diversity of situations, we suggest three paths of ageing in IH which alternately constitute three illustrations of the notions of *emprise*, *reprise* et *déprise*.

The daily sociability of elderly people in a shopping center: a peculiar leisure. Bulletin de l'association de géographes français, 95-1 | 2018, 79-96. Thibaut Besozzi

Studying groups of elderly people who meet every day in a shopping center located in the city center, this article shows how people create their own place in the shopping mall and divert the conventional uses and signification to transform it in a meeting place. Their sociability appears as leisure, a playful form of socialization, which contains important identity issues, but creates problems with the economic logic of the shopping center because they never consume. In that sense, we can question this kind of leisure and the normalization of space process which aims to control this diversion of space

State of the Art report on Design Methodology (2015) David Andrews and Stein Ove Erikstad, 12th International Marine design Conference Tokyo, Japan

Although this paper is from another discipline it does serve as an example of how design methodology is central to and design project covering design for risk, literature review and handling uncertainty in future operating context. This may be helpful for the designers of Sheld-on.

Ambient Intelligence Environments with Wireless Sensor Networks from the Point of View of Big Data and Smart & Sustainable Cities. [IEEE Access](#) (Volume: 6) 34631 – 34642. 20 June 2018 ISSN: 2169-3536 DOI: [10.1109/ACCESS.2018.2849226](https://doi.org/10.1109/ACCESS.2018.2849226) M. Espinilla(1) ; L. Martínez(1); J. Medina(1) ; C. Nugent(2).

(1) Department of Computer Science, University of Jaén, Spain

(2)School of Computing, University of Ulster at Jordanstown, U.K.

In the context of ambient-assisted living and monitoring activities and behaviours, the concept of smart homes/environments has emerged as a research and development field with many examples appearing in a range of different contexts (universities, research centres, hospitals, residences, etc.). Recently, a Smart Lab called UJAml based on Ambient Intelligence was created at the University of Jaén in order to provide an environment where solutions in assistive technologies could be developed. This paper presents the experience of developing this smart lab within its first year. The initial space assigned to the smart lab is described through the creation of the smart lab in five perspectives: the layout of the smart lab, the selection of the devices, the deployment of the middleware, the technical infrastructures and the furniture. Finally, following our experience of creating the lab we reflect upon our experience and provide a set of guidelines and recommendations. Ongoing projects within this Smart lab are also introduced.

RADAR SENSOR SYSTEM FOR MONITORING ELDERLY PEOPLE AT HOME. UPCommons. Portal de acceso abierto al conocimiento de la Universidad Politécnica de Cataluña, España. Trabajo final de grado 2018-01. Catalán Mor, Joan Bru <http://hdl.handle.net/2117/117778>

Considering the aging society tendency that the whole world is experiencing, the percentage of elderly people will incrementally represent a larger share of the total population. Older adults are more prone to develop health problems. For them to be successfully treated, early detection is crucial. So as to facilitate this, monitoring them will make for a remarkable improvement. A radar sensor which enables this possibility is what this thesis is about. Starting from an already developed project, several parts have been modified to make the system more efficient. The contributions implemented in the practical work of the thesis are about the modification of the functioning of the system, adding a more secure way of storing the data by introducing a Raspberry Pi for such purposes. Moreover, a PIR sensor, which is used to detect movement, is also added to the structure providing several benefits to improve the performance of the whole system. Last but not least, since this project affects the privacy of its users, an ethical discussion has been carried out to assure its viability.

SMART SENSORY FURNITURE BASED ON WSN FOR AMBIENT ASSISTED LIVING. IEEE Sensors Journal (Volume: 17 , Issue: 17 , Sept.1, 1 2017)pp. 5626 – 5636. (29 June 2017). Andres L. Bleda ; Francisco J. Fernández-Luque ; Antonio Rosa ; Juan Zapata; Rafael Maestre. DOI: [10.1109/JSEN.2017.2721434](https://doi.org/10.1109/JSEN.2017.2721434)

Ubiquitous computing has been defined as “machines that fit the human environment instead of forcing humans to enter theirs.” An example of this type of approach is “Smart Sensory Furniture” (SSF) Project. SSF is an ambient assisted living system that allows inferring a potential dangerous action of an elderly person living alone at home. This inference is obtained by a specific sensory layer with sensor nodes fixed into furniture and a reasoning layer embedded in a PC that learns from the users' behavioral patterns and advices when the system detects unusual patterns. This paper aims to explain the SSF sensory layer, which is a distributed signal processing system in a network of sensing objects massively distributed, physically coupled, wirelessly networked, and energy limited. A complete set of experimental test has been carried out. The results show the level of accuracy for each type of sensors and potential use. Finally, the power consumption was experimentally measured and the results show the low maintenance requirements of this solution. The complete system design is described and discussed, including the node mesh details, as well as the type of sensors and actuators and other aspects, such as integration issues and solutions.

A SMART KITCHEN FOR AMBIENT ASSISTED LIVING. SENSORS 14, 1 (2014), 1629-1653; doi:10.3390/s140101629. Rubén Blasco (1), Álvaro Marco (1), Roberto Casas (1), Diego Cirujano (1) and Richard Picking (2).

The kitchen environment is one of the scenarios in the home where users can benefit from Ambient Assisted Living (AAL) applications. Moreover, it is the place where old people suffer from most domestic injuries. This paper presents a novel design, implementation and assessment of a Smart Kitchen which provides Ambient Assisted Living services; a smart environment that increases elderly and disabled people's autonomy in their kitchen-related activities through context and user awareness, appropriate user interaction and artificial intelligence. It is based on a modular architecture which integrates a wide variety of home technology (household appliances, sensors, user interfaces, etc.) and associated communication standards and media (power line, radio frequency, infrared and cabled). Its software architecture is based on the Open Services Gateway initiative (OSGi), which allows building a complex system composed of small modules, each one providing the specific functionalities required, and can be easily scaled to meet our needs. The system has been evaluated by a large number of real users (63) and carers (31) in two living labs in Spain and UK. Results show a large potential of system functionalities combined with good usability and physical, sensory and cognitive accessibility.

INTEGRATION OF MULTISENSOR HYBRID REASONERS TO SUPPORT PERSONAL AUTONOMY IN THE SMART HOME. SENSORS. 2014; 14(9):17313-17330. Miguel Ángel Valero (1), José Bravo (2), Juan Manuel García Chamizo (3) and Diego López-de-Ipiña (4) DOI:10.3390/s140917313.

The deployment of the Ambient Intelligence (Aml) paradigm requires designing and integrating user-centered smart environments to assist people in their daily life activities. This research paper details an integration and validation of multiple heterogeneous sensors with hybrid reasoners that support decision making in order to monitor personal and environmental data at a smart home in a private way. The results innovate on knowledge-based platforms, distributed sensors, connected objects, accessibility and authentication methods to promote independent living for elderly people.

TALISMAN+, the Aml framework deployed, integrates four subsystems in the smart home: (i) a mobile biomedical telemonitoring platform to provide elderly patients with continuous disease management; (ii) an integration middleware that allows context capture from heterogeneous sensors to program environment's reaction; (iii) a vision system for intelligent monitoring of daily activities in the home; and (iv) an ontologies-based integrated reasoning platform to trigger local actions and manage private information in the smart home. The framework was integrated in two

real running environments, the UPM Accessible Digital Home and MetalTIC house, and successfully validated by five experts in home care, elderly people and personal autonomy.

AMI AND DEPLOYMENT CONSIDERATIONS IN AAL SERVICES PROVISION FOR ELDERLY INDEPENDENT LIVING: THE MonAMI PROJECT. SENSORS 13 (2013), 8950-76. Falcó, Jorge; Vaquerizo, Esteban; Laín, Luis; Artigas Maestre, José Ignacio; Ibarz, Alejandro DOI: [10.3390/s130708950](https://doi.org/10.3390/s130708950)

The MonAMI project aims to investigate the feasibility of the deployment of open platforms for Ambient Assisted Living (AAL) services provision based on Ambient Intelligence (Aml) and to test user acceptance and the usability of the services. Services were designed to provide support in the areas of environmental control, security, well-being and leisure. These services were installed and evaluated in a Spanish geriatric residence. The participants included elderly persons with disabilities, nursing home care givers and informal carers. The concept of the open platform proved to be satisfactory for the provision of the services in a context aware framework. Furthermore, the usability of the technology was viewed positively and the overall results indicate that this system has the potential to prolong independent living at home for elderly people with disabilities. Deployment was proven successful and awareness of open-platform AAL service delivery was raised in local communities throughout Europe.

EVOLUTION TOWARDS BETTER AAL ENVIRONMENTS. 2013 Seventh International Conference on Innovative Mobile and Internet Services in Ubiquitous Computing. 3-5 July 2013. Taichung, Taiwan. Andres L. Bleda (1); Rafael Maestre (1); Guadalupe Santa (1); Soledad Pellicer (1); Antonio J. Jara (2); Antonio Gómez Skarmeta (2)

DOI: [10.1109/IMIS.2013.92](https://doi.org/10.1109/IMIS.2013.92)

The huge and continuous growth in population age, and the necessity to encourage their independent life with the goal of improving their quality of life and remote assistance, result in a constant evolution in AAL environments. The appearance of new AAL systems including new functionalities, and the integration of them in familiar environments, as homes, need an exhaustive study of current AAL systems and where they go, their expectations and future evolution. This paper shows a coherent evolution of such systems based on the expertise and particular view of the Department of Electronics and Home Automation of CETEM. It emphasizes in the integration of AAL systems at home in a pervasive way and describes a successful developed project which supports pervasive aspects of integrating these systems at home. It also shows the integration of new eHealth functionalities into AAL systems and describes the objectives of an actual R&D project under development. All that makes for better AAL systems but there still exists other improvement fields focused on the autonomy of this kind of systems that are analyzed in the paper and proposed for future work.

Wireless sensor network deployment for remote elderly care monitoring. Athanasios Dasios, Damianos Gavalas, Grammati Pantziou, Charalampos Konstantopoulos

ISBN: 978-1-4503-3452-5

This paper reports hands-on experiences in designing, implementing and operating a wireless sensor network (WSN)-based prototype system for elderly care monitoring in home environments. The monitoring is based on the recording of environmental parameters like temperature, humidity and light intensity as well as micro-level incidents which allow to infer daily activities like moving, sitting, sleeping, usage of electricity appliances and plumbing components. The prototype is built upon inexpensive, of-the-shelf hardware (e.g. various sensors, Arduino microcontroller platforms, ZigBee-compatible wireless communication modules) and license-free software, thereby ensuring low system deployment cost. Upon detecting significant deviations from the ordinary activity pattern of individuals and/or sudden falls, the system issues automated alarms which may be forwarded to

authorized persons via a variety of communication channels. Furthermore, measured environmental parameters and activity incidents may be monitored through web interfaces.

Stasidia (CHURCH STALLS) of the greek orthodox church – a standing seat for elderly. Ioannis BARBOUTIS, Vasileios VASILEIOU Faculty of Forestry and Natural Environment, Aristotle University of Thessaloniki. Proceedings of the XXVIth International Conference Research for Furniture Industry. In Greek Orthodox Church and the liturgy taking place there, the worshipers tend to stay up standing most of the time. Especially in monasteries, the elderly people (monks) need to be facilitated in attending the liturgies of long duration and therefore, a series of chairs of special type called stasidia or stalls, are placed in the church, between the columns of the aisles. The design of this ecclesiastical furniture is unique and appears only in Orthodox Church. Stasidia are made of several wood species and constructed in such a way, that the elderly people are supported by the backrest and arms of the furniture. Initially, the stasidi was stable, whereas subsequently a moveable wooden element (misericord) was added in the structure, in order to offer a slight support to standing worshipers. The aim of this furniture construction is more to facilitate and support the people standing, rather than people seating during the worship or prayer. As the decades passed, this kind of ecclesiastical chair was transferred and spread from the monasteries to the rest of churches and the stasidi from a furniture of simple design and construction, of plain assembly of wooden elements, transformed into a furniture of more complicated design, more ornamental, that now brings several furnishings and decorative carvings in the surfaces of back and arms. The main goal of this work is to examine the evolution of architecture and designs of stasidia through the centuries and the study of designs and manufacturing processes of stasidia today.

CRITICAL POINTS IN THE CONSTRUCTION OF AGED PEOPLE FURNITURE. Vasiliki KAMPERIDOU. ISSN 2069-7430 ISSN-L 1841-4737

Even though the economic crisis has influenced the shopping behavior of all people, elderly between 65 and 69 still consume and spend more money on furniture than younger people. Despite of this, furniture manufacturers seem to lack knowledge about the diverse needs of aged people, referring to furniture, mainly because of a poor communication between furniture industry and its end-users. In this study an attempt to approach and categorize the requirements and needs of aged people using furniture in their everyday life is implemented. The study used approximately 100 interviews with elderly people that were carried out on a continual process that lasted around 1.5 years in several furniture stores of Thessaloniki (North Greece), gathering data and information in a frame of conversations, trying to reach a deeper understanding of their habits, needs and requirements related to furniture. The results, were also correlated to corresponding literature, and revealed common wishes and needs for furniture that provide comfort, safety, functionality, pleasure and independence, since furniture could help elderly people continue to be active and self autonomous.

Market potential and determinants for eco-smart furniture attending consumers of the third age. Competitiveness Review, Vol. 26 Issue: 5, pp.559-574, Ioannis Papadopoulos, et al. <https://doi.org/10.1108/CR-06-2015-0058>

This paper aims to discuss some of the findings of an ongoing “Green & Smart Furniture” (GSF) research project. It actually focuses on third-age consumers’ behavior and interest in purchasing smart and eco-friendly wooden furniture, providing some critical implications for the successful design and production of GSF products in the framework of innovation and differentiation.

A novel accessibility assessment framework for the elderly: evaluation in a case study on office design. Panagiotis Moschonas, Ioannis Paliokas, Dimitrios Tzouvaras. ISBN: 978-1-63190-011-2 Elderly and impaired persons constitute an important part of our societies. Existing practices to test accessibility features on forthcoming consumer products and services rely on tests with real

impaired users on the industrial prototypes. Our approach comes to automate the evaluation process and introduce it in early phases of the product design. The proposed accessibility assessment framework is based on the Virtual User Models (VUMs) concept. VUMs are models containing several parameters used for the emulation of the behavioural characteristics of impaired and elderly populations. In this paper, the simulation framework and a number of VUMs corresponding to real persons are evaluated using two variations of a workplace office design. Results indicated that VUMs are efficient predictors of the corresponding end user's behaviour and thus, their simulated performance can lead into decision making during the product test-and-redesign cycles.

Moving house and housing preferences in older age in slovenia Maša Filipovič Hrast, Richard Sendi, Valentina Hlebec, & Boštjan Kerbler, (2018) Taylor Francis.

In situations where older adults require extensive care, more than 70% of them find old people's home "acceptable" or "perfectly acceptable". Interestingly, sheltered housing is perceived as more negative, although it offers some advantages compared to old people's homes. Among the reasons for this may be unfamiliarity with the sheltered housing and large financial burden it poses.

The relationship of the elderly toward their home and living environment

Boštjan Kerbler, Richard Sendi, & Maša Filipovič Hrast, (2017)

The analysis confirmed the assumption that the Slovenian elderly are also very attached to their homes or home environments and are satisfied with living there. In addition, the analysis showed some differences among the elderly in this regard depending on their age, where they live, and how long they have been living in their current homes.

Healthy ageing at home: Ergonomics adaptations of interior design and self-assessed quality of life of older adults of the municipality of Ljubljana

Jasna Hrovatin, Saša Pišot, & Matej Plevnik, (2016)

The results showed that there is a significant difference between the subjective evaluation of the participants and the evaluation by the professionals regarding the estimation of appropriate lighting. The participants who estimated their quality of life as better are more likely to have sufficient or adequate lighting and more adaptations in the kitchen, which makes daily kitchen work easy and safe. Further investigation dealt with the ergonomic adaptation of the bathrooms, where we found out that less than 15 % of the participants installed the handrails in the shower or bath tub, which can significantly contribute to safety. Additionally, physical capability as part of quality of life negatively correlates with the number of adaptations made in bathroom ($r = -0.149$; $p = 0.039$), which refers to the fact that the adaptation of accessories (handrails) were only installed when the need for them appeared. With minor changes in the living environment and taking care for maintaining psycho-physical capabilities, older adults can easily and safely perform everyday tasks, which prolongs an individual's autonomy and independence – the fact we are still not sufficiently aware of.

Ergonomic suitability of kitchen furniture regarding height accessibility

Jasna Hrovatin, Silvana Prekrat, Leon Oblak, & David Ravnik, (2015)

The study, carried out using a computer simulation model, analyzed the products of three Slovenian kitchen manufacturers. The cross section of accessibility in the wall cabinets was determined for different age groups of men and women. The results show that the efficacy of the volume in wall cabinets higher than 600 mm, in comparison to places where objects are easily reachable, is 30% lower for women, thus indicating the inefficiency of storage space in wall cabinets. In terms of accessibility, existing kitchens are not optimal for the elderly, and a model with a deeper worktop and wall cabinets lowered onto the worktop is proposed. Accessibility in such wall cabinets is increased by up to 70% if the body is moved forward by 30°.

[Adaptability of kitchen furniture for elderly people in terms of safety](#)

Jasna Hrovatin, Kaja Širok, Simona Jevšnik, Leon Oblak, & Jordan Berginc, (2012)

This research was carried out via individual surveys at the respondents' homes. 204 respondents participated in the research. The results show that most users do not realize that, with more appropriate kitchen equipment, they could perform daily tasks faster, safer, and with less effort. Common shortcomings include insufficient lighting (32 %), inappropriate sequential composition of work surfaces (56 %), ease of hygiene maintenance (68 %), inappropriately - shaped furniture (72 %), and tasks that become troublesome because of declining memory (75 %). It is necessary to design kitchen equipment specifically adjusted for the needs of the elderly.

[Risk for falls in home environment](#)

Marija Tomšič & Mojca Gunčar, 2012

Both in cities and in villages, most subjects are at a medium risk level of falling. The most typical risks in the living environment are unmarked edges of the steps, which present a problem in more than 80% of all surveyed subjects. Similarly, in most cases, subjects reported that rugs increase their risk of falling. In more than half of all cases, the risk of falling is increased by 1) inappropriate carpets or other objects placed in hallways, 2) absence of non-slip materials in the bathrooms, and 3) hard to reach objects.

[Preferences of Polish and Slovenian seniors concerning kitchen interior design](#)

Beata Fabisiak & Jasna Hrovatin, (2014)

The preferences are related to the comfort and evoking positive feelings, sense of security and relaxation, closeness to nature, and childhood memories of home. Older adults prefer cosy spaces that are large and bright, full of plants, equipped with furniture, and elements made of natural materials, especially solid wood. Respondents from both countries agreed that style and colours of kitchen should have a relaxing and optimistic impact on their mental and physical state. Investigations on preferred colour range revealed that the elderly choose warm colours with pastel tones more likely for their ideal kitchen interior design.

[Physical barriers and the use of assistive devices in senior citizens' everyday life](#)

Mateja Berčan, Majda Pajnkihar, Jože Ramovš, & Zmago Turk, (2010)

The age-related problems often necessitate the use of assistive devices to secure safety, autonomy and independent living of the elderly, especially the availability of telephone communication (landline, 100 %) and the assistive devices for people with movement disorders (walking canes, 27 %). The majority of the respondents also expressed the need for adaptations to their internal and external home environment (installing handles, 69 %) and for physical barrier removal at home and in public areas.

Small spacecraft technology State of the Art. Ames research centre, California, NASA/TP–2015–216648/REV1 (2015)

This report is concerned with space technology for small crafts and hence has information that may be useful to Sheld-on, including materials, thermal control, and ground data systems and operations.

Ambient Assisted Living, Italian Forum (2017) Cavallo, F., Marletta, V., Monteriù, A., Siciliano, P.
<https://www.springer.com/it/book/9783319542829>

This book documents the state of the art in the field of ambient assisted living (AAL), highlighting the impressive potential of novel methodologies and technologies to enhance well-being and promote active ageing. The coverage is wide ranging, with sections on assistive devices, elderly people monitoring, home rehabilitation, ICT solutions for AAL, living with chronic conditions, robotic assistance for the elderly, sensing technologies for AAL, and smart housing. The book comprises a selection of the best papers presented at the 7th Italian Forum on Ambient Assisted Living (ForitAAL 2016), which was held in Pisa,

Italy, in June 2016 and brought together end users, technology teams, and policy makers to develop a consensus on how to improve provision for elderly and impaired people. Readers will find that the expert contributions offer clear insights into the ways in which the most recent exciting advances may be expected to assist in addressing the needs of the elderly and those with chronic conditions.

Adaptability of Kitchen Furniture for Elderly People in Terms of Safety (2012) J. Hrovatin et al. 10.5552/drind.2012.1128

CIRDO: Smart companion for helping elderly to live at home for longer (2014) S. Bouakaz et al. 10.1016/j.irbm.2014.02.011

Cyber-physical cloud-oriented multi-sensory smart home framework for elderly people: An energy efficiency perspective (2017) M. S. Hossain et al. . <http://dx.doi.org/10.1016/j.jpdc.2016.10.005>

Delivering home healthcare through a Cloud-based Smart Home Environment (CoSHE) (2018) M. Pham et al. <https://doi.org/10.1016/j.future.2017.10.040>

Design and evaluation of a smart insole: Application for continuous monitoring of frail people at home (2018) Y. Charlon et al. <https://doi.org/10.1>

Design for AAL Integrated Furniture for the Care and Support of Elderly and Disabled People (2017) P. Beer et al. 10.5552/drind.2017.1642

Evaluation of Three State-of-the-Art Classifiers for Recognition of Activities of Daily Living from Smart Home Ambient Data (2015) T. Nef et al. 10.3390/s150511725

Furniture for Later Life. O

Johnsson PhD thesis.

Department of Design Sciences, Division of Industrial Design. ISBN 978-91-7473-706-6

Smart Home Assistant for Ambient Assisted Living of Elderly People with Dementia (2015) E. Demir et al. 0.1016/j.procs.2017.08.302

Smart homes and home health monitoring technologies for older adults: A systematic review (2016). L.Lieu et al. <http://dx.doi.org/10.1016/j.ijmedinf.20>

Smart Homes for Elderly Healthcare—Recent Advances and Research Challenges (2017) S Majumder. Sensors. 10.3390/s17112496

The Elderly's Independent Living in Smart Homes: A Characterization of Activities and Sensing Infrastructure Survey to Facilitate Services Development (2015) Sensors. Q. Ni et al. 10.3390/s150511312

Exergame technology and interactive interventions for elderly fall prevention: A systematic literature review (2017) Choi. Et al. <http://dx.doi.org/10.1016/j.apergo.2016.10.013>

[Photodiodes embedded within electronic textiles.](#) (2018) Scientific reports 8 (1): 16205. SATHARASINGHE, A., HUGHES-RILEY, T. and DIAS, T., ISSN 2045-2322

[Developing novel temperature sensing garments for health monitoring applications.](#) (2018) Fibres, 6 (3) : 46 LUGODA, P., HUGHES-RILEY, T., OLIVEIRA, C., MORRIS, R. and DIAS, T. ISSN 2079-6439

[*A historical review of the development of electronic textiles.*](#) (2018) HUGHES-RILEY, T., DIAS, T. and CORK, C.R., *Fibers*, 6 (2): 34. ISSN 2079-6439

[*Design for the environment in UK product design consultancies and in-house design teams: an explorative case study on current practices and opinions.*](#) (2013) RADLOVIC, P.F.M., LEMON, M. and FORD, P., *The International Journal of Design Management and Professional Practice*, 6 (2), pp. 73-83. ISSN 2325-162X

Websites

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<http://www.newdynamics.group.shef.ac.uk/design-for-ageing.html>

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Other outputs types

Other forms of examples of State of the Art are given here,

Research projects in France

Habitat seniors, the first full adaptable accommodation designed by and for FCBA, Sarah Couillaud, Yoann Montenot, Clément Grange. Habitat Seniors is the product of a consortium of French industrial groups, headed up by the FCBA. This is the first co-innovation project for adaptable habitats, designed from the ground up to adapt to seniors' residential needs. With this in mind, the developers, architects, manufacturers and users have all been involved throughout the design process, continually learning and improving in an effort to provide real solutions that meet the growing demand from seniors to stay in their own homes as long as possible. Several products were developed during this program

New Product : *ENTRY & IRONING SPACE* Manufacturer: Optimum. Optimum has designed a cabinet which brings together all the functions needed in this space. Equipped with storage space and an ironing board, this keeps everything close at hand so there's no unnecessary movement or actions needed. Here, items "come to the seniors", so the residents don't need to bend down or work to access them - but nor are they ever in the way. A helper can perform these household tasks while still being able to talk to the senior and keep them company. They will also be out of the way if the senior is resting. What's more, it acts as a support to polish shoes, or even to just sit and have a rest thanks to the built-in fold-down seat

New product : *WALL CABINET WITH INTEGRATED DOOR & FLOOR* Manufacturer: Righini and Optimum. Optimum and Righini filed a joint patent for this wall cabinet, equipped with an integrated

door and various different storage spaces. They drew on the skills and expertise of the Blum Company to design their interior solutions. This partition is mobile and can be moved by a professional, adapting the living space as and when necessary. Thanks to the built-in soundproofing inside this unit, the residents can do two different things in two rooms without disturbing each other. What's more, Gerflor has provided a soft floor which provides protection against falls which is pleasant underfoot, soundless and resistant to punctures and dents from heavy objects, while Evidences Mobilier kitted out the living room with some armchairs featuring removable seats or casters and an integrated walking stick holder, an end table and a light, mobile table which can be moved easily.

New product : *ILLUMINATED ACCESS DOOR* Manufacturer: Righini and SFL, lighting specialists. Righini and SFL, lighting specialists, put their expertise to work for the Habitat Seniors project and joined forces to develop a door integrated into the removable wall-cabinet, co-patented by Optimum and Righini and fitted with a low-energy lighting system. The LED lights show the senior where the door is, reducing the risk of falls and knocks. It runs off its own battery which recharges automatically when the door is closed, creating a lighting solution in the event of a power cut. This core interior design feature is both reassuring and decorative, and helps preserve a senior's independence - even if they are visually impaired.

Research projects in Slovenia

[The Research Centre of the Creative Furniture Industry \(RC31\)](#) takes part in research and development projects, while promoting the use of wood as Slovenian sustainable raw material and encouraging development of high value added products, top design and high-quality production. Among other goals, it aims to develop furniture adapted to older adults.

International project HELPS, with the goal of supporting the elderly in regard to their habitats, resulted in a [brochure](#) explaining the effective adaptations of indoor environments to the older adults.

Staff and students of the Slovenian Faculty of Design visited older adults at their homes to assess which adaptations would be the most useful to them. It was discovered that most adaptations are needed in bathrooms and kitchens. Computer visualizations of both minor (but simple and inexpensive) and substantial indoor adaptations were prepared for older adults, who were satisfied with the project and wished for these services to be available to them in the future. Following the project, a manual was prepared for the older adults, which presents common problems and adaptations of living environments ([source](#), [source](#)).

Research Projects Sweden

Design4All (2013-16) <http://www.d4all.eu/en>

Active ageing @ home (2013-16) <http://activeageingathome.eresult.it/progetto/>

Managing Active and healthy aging with use of caRing service robots Managing Active and healthy aging with use of caRing service robots (2016-18) <http://www.mario-project.eu/PORTAL/>

In the year 2017, a project titled “[Model for quality ageing in home living environment](#)” began. The goal of this project is to investigate what are the needs and wishes of the elderly and which obstacles and shortcomings they face in their dwellings.

Other output types:

Manufacturers and products

[Interteam](#) is a Slovenian company that offers specialized products to furnish dwellings of the elderly.

Courses

Since 2016, there is a course titled “Innovative forms of living for the elderly.” at the European Faculty of Law (Department of Infrastructure and Real Estate Management) in Slovenia. The course is specifically designed to inform future decision makers about the useful improvements to the habitats to suit the needs of the elderly. The lecturer is dr. Boštjan Kerbler ([source](#)).

Exhibitions and trade fairs

In the year 2018, there was [an exhibition](#) at the Slovenian Urbanistic institute presenting the planning of the living environment of the elderly. This was the culmination of the two years of work of landscape architecture students.