

# 3D4ELDERLY

PROJECT NUMBER: 2020-1-LT01-KA204-077896

**IO1A1 - PART 2 - Transfer of knowledge about the basics of 3D printing concepts to the caregivers' staff working with people with Alzheimer and elderly people with dementia.**

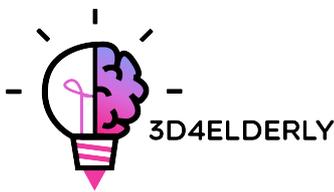
CONSORTIUM OF PARTNERS:





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## 1. Some basic points about Alzheimer and dementia

**Alzheimer's disease (AD)** is a neurological degenerative disease that mainly affects people over 65, although sometimes it may occur at an earlier age. The disease develops gradually, with initial symptoms of being easily distracted and slightly confused, but as it progresses, the person with AD loses their memory, orientation in time and space, ability to write, read and speak, they become frightened, depressed, and aggressive and eventually lose their personality. Due to the progressive decline in intellectual, mental, and physical abilities, it becomes impossible for a person with AD to take care of themselves. In its final stages, the disease leads to a complete loss of mental and motor abilities. The most common early symptom of AD is having problems with memorizing new information, as the disease usually first affects the part of the brain associated with learning.

AD usually occurs in **three phases**, but the boundaries between them are not strictly defined and much depends on the specific circumstances:

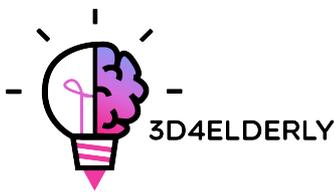
- mild or early stage: between 2 and 4 years
- moderate or middle stage: between 2 and 10 years
- severe or late stage: between 1 and 3 years

It is important to note that dementia covers a group of degenerative diseases – **it is not just a part of the normal ageing process**. The deficiencies are caused by damage to the brain cells, which interferes with their ability to communicate with each other and affects thinking, behaviour, and feelings. Different types of dementia can impact people in different ways. Alzheimer's disease is the most common cause of dementia (50 to 70% of cases). Other forms of dementia include: vascular dementia, front-temporal dementia, Lewy body disease, Pick's disease, Binswanger disease and others.

## 2. Risk factors

**Risk factors** for developing dementia are:

- Age: the risk of developing the condition doubles approximately every five years over the age of 65.
- Decreased blood supply to the brain: midlife high blood pressure, high cholesterol or obesity.
- Genetics and changes in the chemical composition of the brain: some of the dementia disorders such as Alzheimer's disease and Lewy body dementia may be caused by genetic anomalies passed down in the family. But science cannot explain why some people who carry the gene mutation do not develop the disease with age.



- Other diseases: diabetes, depressive episodes, heart disease, sleep apnea, hearing loss.
- Lifestyle and nutrition: maintaining mental and physical activity throughout life, social contacts, following the Mediterranean diet and other healthy choices reduce the risk of dementia and slow down the development of symptoms.

### **3. Skills, capabilities that people with Alzheimer's disease (AD) and other dementias could have decreased**

A person can function independently during the early stages of AD and other dementias. They may still be able to drive, work and enjoy social activities. However, they may have trouble finding the right word in a conversation or it may become increasingly difficult to navigate the city they have lived in for many years.

The capabilities that a person with dementia loses (and warning signs of cognition challenges) are:

- The ability to use properly the correct word or name;
- To memorize names when meeting new people;
- To perform routine professional tasks or social communications.
- Remembering a recently read text;
- Preservation of important documents or items;
- Planning and organizing activities.

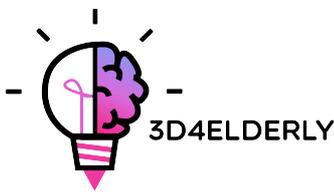
The moderate stage of AD is usually the longest in duration. As the dementia progresses, the person increasingly loses independence and needs more support. Finding words will be a challenge and the person may become angry or rude. They may insist on making interesting decisions, e.g. refuse to bathe. The damage to nerve cells in the brain prevents the person from expressing their thoughts and perform routine tasks without assistance.

The abilities that a person with dementia in the second stage begins to lose are:

Recall for personal history, information and recent events;

Motivation for social contacts, especially when meeting new people where additional efforts are required;

- Orientation in time and location in the present moment;
- Selecting the right clothes for the season and putting them on in the right order (e.g. puts a vest under the shirt);
- Bladder control resulting in incontinency;
- Normal sleep patterns - sleeps during the day and becomes restless at night;
- Acquires a tendency to wander and often gets lost;



- Drops the social mask and demonstrates changes in personality and behaviour (psychotic manifestations) such as suspicion and hallucinations, or compulsive (repetitive) behaviour such as washing hands or cutting paper or cloth.

During the middle stage of dementia, a person can still perform daily activities, but needs support. The support becomes greater as the condition progresses. It is very important to motivate and encourage the person to perform the activities they are still capable of, for instance by simplifying the tasks and dividing them into small steps.

In the **late stage** of dementia, the symptoms are severe. The person with dementia loses the ability to interact with the surrounding environment, to conduct a conversation and finally loses mobility. They may still be able to form a single phrase or a few words, but the communication is very difficult. As the mental and cognitive abilities continue to deteriorate, the person will need constant care.

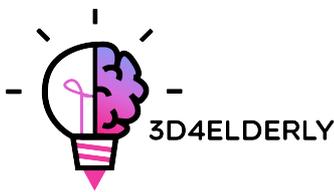
In the **final stage** the person with dementia:

- Needs 24/7 personal hygiene care;
- Has difficulty to communicate and express feelings and needs;
- Is mobility challenged, including walking, sitting and eventually swallowing;
- Loses orientation and sense of personal experience;
- Becomes susceptible to various infections especially pneumonia

The person with dementia in the late stages may have lost a lot of their capabilities but they can still experience pleasure from listening to favourite music for example or can be calmed down with an appropriate tender approach.

#### **4. Consequences and tips in daily life for a person with Alzheimer's disease and other dementias**

Due to difficulties with memory and recall, a person with dementia may experience various confusing situations and decline social contacts or be rejected from their social network. This leads to social exclusion and loss of identity. It's a vicious circle because social exclusion further impairs physical and mental health. However, it's already been demonstrated that people with dementia can live well and longer with appropriate support. Such support should include assistance in coping with the physical, psychological and social challenges that arise through the course of dementia both for the person with dementia and for the informal caregivers. Maintaining connections with the local community and friends is also vital to the well-being of the person with dementia and their family.



Useful tips on how to preserve contacts and make new connections:

- Communicate openly about the challenges related to dementia with family and friends from the very start. Sharing will help others understand the difficulties that the person with dementia has to deal with on a daily basis.
- Articulate clearly the feeling of rejection and isolation.
- Look for new and appropriate support groups within the community that will offer valuable relationships.
- Pursue a new hobby or activity that will be helpful to forging respective connections.

It's crucial to master the three main challenges a person with dementia in the early stages is faced with: loneliness, helplessness, and boredom.

The possibility to engage in meaningful activities and remain connected is deemed essential to slowing the progression of dementia.

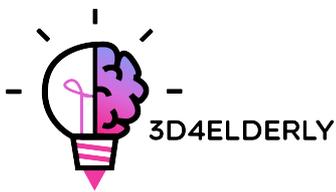
## **5. Life environments and care systems for people with Alzheimer**

There are various care systems for people with dementia in European countries, tailored to the respective health and social systems and the management of funding for the organization of care services in different countries.

In most cases the care for a person with dementia is predominantly provided by family members at the person's home. Due to the specifics of the syndrome, such care is associated with a significant multifaceted burden – physical, financial, mental, and emotional. This burden is so well known to specialists in the field that it has been recognized with a specialized term as the "burden of care", and is associated with negative consequences for the physical and mental health of the caregiver. Home care support is available to varying degrees and could be funded by state aid to some extent.

Day care centres: research in the field unequivocally demonstrates the benefits of day care centres for the caregivers.[1] According to documented data,

- Thanks to the day care centres, caregivers have time for uninterrupted work, rest, or other activities
- Day care centres reduce behavioural problems in people with dementia, but there is a lack of well-documented research in this area and the conclusion is somewhat based on impressions



- Day care centres relieve the burden of care, stress and depression and generally improve the quality of life for the family
- By offering information and support to families, day care centres increase the motivation of family members to continue caring for the patient, thus delaying the need for institutional care.

Residential care homes: various types and combinations are known throughout Europe but depending on the level of support and care provided they can be divided in following groups:

Retirement housing is available for people in the early stages who are still able to function independently. Supervision is limited and the number of residents is small

- Assisted living offers a combination of housing, meals, supportive services, and health care
- Nursing homes provide 24/7 care and long-term medical treatment, usually with 30 to 80 residents
- Hospices provide palliative end of life care

**Memory care units** are designed to meet the specific needs of individuals with Alzheimer's and other dementias. They can take many forms and exist within various types of residential care, including assisted living facilities, and they may or may not be locked or secured units.

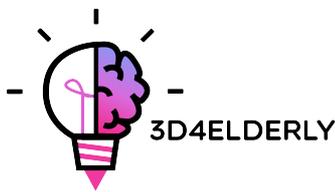
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[1] Reference: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5216603/>

## 6. Caregivers (roles and needs)

The caregiver is a person who supports and older person who is ill and/or has dementia. When the caregiver supports a family member or a friend he or she is regarded as informal caregiver. The caregiver supports the person with dementia on a daily basis to deal with small and significant challenges. The burden of caregiving can increase the risk for significant health problems and many dementia caregivers experience depression, high levels of stress, or burnout. Nearly all Alzheimer's or dementia caregivers at some time experience sadness, anxiety, loneliness, and exhaustion. Seeking help and support along the way is not a luxury – it's a necessity.

Most older people who are ill depend on the unpaid help of a family member, neighbours or friends instead of hiring a professional caregiver due to a variety of reasons, including financial.



The list of tasks and responsibilities of the caregiver, regardless of whether professional or informal, is endless. The ones below are some of the typical daily duties:

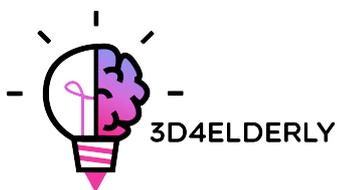
- Shopping assistance
- Support for cooking, laundry, house cleaning and various domestic chores
- Assistance while bathing, dressing and taking medications
- Accompanying the person with dementia to the doctor for medical procedures and screenings, ambulatory manipulations
- Ensuring appropriate exercise and dietary regime is observed, maintaining social activities and networks
- Planning of sustainable flexible daily routines as well as establishing a roadmap for the anticipated challenges throughout the progression of dementia
- Management of emergency and/or crisis situations
- Dealing with challenging behaviours
- Learning to communicate adequately and effectively with the person with dementia
- Arranging for practical and meaningful activities for the person with dementia

## 7. Therapies

Various approaches to memory training exist and new ideas are constantly being developed. Below are the most common methods and therapies used:

**Cognitive rehabilitation:** individually tailored intervention applied for working on personal goals, often using external cognitive aids and some use of learning strategies. This could be a simple task of trying to remember the items on a tray or the sequence of figures in a long number. Additionally, there are many online games and apps that stimulate the memory. Jigsaw puzzles are also an option, but they should have an interesting picture and be from durable materials (for instance plastic or rubber would be recommended instead of cardboard). A more ambitious challenge would be 3D puzzles, Rubik's Cube, or maze puzzles. Word puzzles like crosswords and wordsearch grids are recommended as well.

**Life review:** a naturally occurring process where the person looks back on their life and reflects on past experiences, including unresolved difficulties and conflicts. This concept was incorporated in a psychotherapy for older people, which emphasizes that life review can be helpful in promoting a sense of integrity and adjustment. Life review therapy has its roots in psychotherapy, involving evaluation of personal (sometimes painful) memories with a therapeutic listener, usually in a one-to-one setting. (Woods et al., in press).

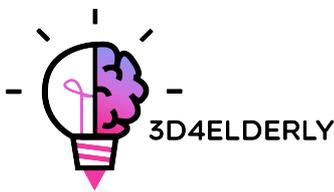


**Reminiscence:** Involves the discussion of past activities, events, and experiences, usually with the aid of tangible prompts (for example, photographs, household and other familiar items from the past, music, and archive sound recordings). Reminiscence therapy in a group context has the aim of enhancing interaction in an enjoyable, engaging fashion. (Woods et al., 1992). Quizzes that are themed to specific relevant decades or historical events are available so that the person can think back, recognize, and remember those times.

**Validation therapy:** based on the general principle of validation, the acceptance of the reality and personal truth of another's experience, validation therapy incorporates a range of specific techniques. Validation, in this general sense, can be considered as a kind of philosophy of care. It is identified as providing a high degree of empathy and an attempt to understand a person's entire frame of reference, however disturbed that might be. Important features of validation therapy are said to include: a means of classifying behaviours; provision of simple, practical techniques that help restore dignity; prevention of deterioration into a vegetative state; provision of an emphatic listener; respect and empathy for older adults with Alzheimer's-type dementia, who are struggling to resolve unfinished business before they die; and acceptance of the person's reality. These features are not, however, unique to validation. (Neal & Barton Wright, 2003).

**Snoezelen** is a multi-sensory stimulation, for example aromatherapy and massage. It provides sensory stimuli to stimulate the primary senses of sight, hearing, touch, taste and smell through the use of lighting effects, tactile surfaces, massage, meditative music and the odour of relaxing essential oils. (Chung et al., 2002). A Snoezelen Room displays optical illusions with combined lighting effects, aromas, colours, textures and sounds to stimulate a person's olfactory, auditory and gustatory systems. Stimulating the senses of the person with dementia has many benefits like mood enhancement, increased socialization, improved cognition functioning and alertness.

- Auditory stimulation is very useful for mood enhancement, cognition, and relaxation. It includes a range of sounds from natural to generated (rainfall or a Mozart symphony). Due consideration should be given to the fact that many people with dementia have hearing problems, and it is essential to stimulate this sense, remembering that adjustments may be needed but loud noises should be avoided as they would be too stressful.
- Tactile stimulation is concerned with awareness of texture and touch. A study by the American Journal of Alzheimer's Disease and other Dementia states that tactile stimulation improves the well-being of people with dementia. Brain paths are used and stimulated every time we use our hands to hold something. It provides stimulation for 3000 nerve receptors in each of our finger tips, and then



these nerves send impulses to stimulate the brain. Things like sandpaper, plastic fruits, and pinecones can also be used in tactile stimulation.

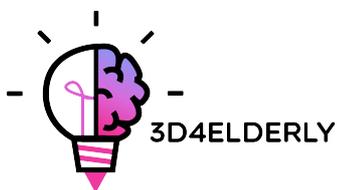
**Visual stimulation:** for instance, bright light therapy is found to be one of the successful therapies for people with Alzheimer's and dementia. Some of the key benefits are improved sleep cycles, decreased wandering, and improved cognition and behavioural functioning. Favourite movies or video clips are also useful for cognitive stimulation. Appropriate decoration is often neglected but a visually stimulating environment can bring forth significant improvement for people with Alzheimer's or dementia. Photos of loved ones or signs in prominent places will have a positive effect in the home.

- Olfactory stimulation: memories are activated by smell. A mere scent is able to connect the person to a place or time from the past. The basic oils utilized as a part of aromatherapy like peppermint, lavender, and rosemary, are well-known, yet aromatherapy is considerably more than sensory stimulation. Distinctive healing properties are asserted for various oils.
- Gustatory stimulation: a favourite dinner or a specific dish is bound to trigger memories. There are many items in the kitchen that can be used to activate the taste buds: various spices and flavourings, like cinnamon, berries, coconut, green and black tea and especially turmeric is said to be a therapeutic herb with calming properties.

**Creative arts therapy** (for example, dance and music) is the intentional usage of the creative arts as a form of therapy (for example, dance therapy, music therapy and drama therapy).

**Cognitive stimulation** (reality orientation) is exposure to and engagement with activities and materials involving some degree of cognitive processing, usually within a social context. The intervention is often group-based, with the emphasis on enjoyment of activities. Reality orientation therapy was described for the first time in 1966 as a rehabilitation therapy for confused elderly people. It is one of the most widely used cognitive enhancement techniques, and numerous procedures have been described. The therapy essentially involves presenting continuous orientation and memory information related to time, place, and person so that the individual may gain a greater understanding of his or her surroundings.

**Animal-assisted therapy:** the use of trained animals in facilitating patients' progress toward therapeutic goals (Barker & Dawson, 1998).



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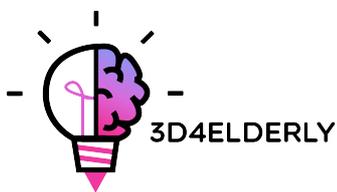
## 8. 3D Printing in Alzheimer

For the purpose of the 3D4ELDERLY project, it is intended to look deeper into 3D printing in a new way: how can this technology help people who is already suffering Alzheimer and dementia?

Advances in medical 3D printing technology have made tremendous contributions to fields throughout healthcare. For patients, new tools and therapeutic methods developed through 3D printing can bring new degrees of comfort and personalization to treatment. For doctors, this newly accessible technology allows for a greater understanding of complex cases and provides new tools that can ultimately result in a higher standard of care.[1]

3D printing's medical applications are increasingly expanding, and it is expected to revolutionize health care. Tissue and organ fabrication; development of customised prosthetics, implants, and anatomical models; and pharmaceutical research into drug dosage formulations, distribution, and exploration are only a few of the existing and future medical applications for 3D printing. It also used even better to understand certain conditions and diseases. It is known that 3D printing technologies have aided significant advancements in the field of healthcare. The potentials of 3D printing could be understood after seeing the impact that the technology has had in so many areas of the healthcare field, for example in the one of Alzheimer's disease. Alzheimer is a chronic neurodegenerative disease, and it is one of the most enigmatic diseases in terms of its causes and treatments up to now.

Connected with that, 3D printing is being used with different functions in Alzheimer field with different functions:



### **3D printed brain model**

As Alzheimer's Disease manifests in the brain, effectively causing parts of the brain to atrophy, understanding the brain's growth and structure could play an important role in eventually finding a treatment for the disease. In 2016, an international team of researchers from US, Finland and France used 3D modelling and printing technologies to recreate a growing brain to better understand how the folds of the human brain's cortex are formed. The 3D brain model was created using magnetic resonance imaging (MRI) scan images of a fetal brain and was made to mimic how real a real brain grows. The process revealed that the brain's growth depends on a physical process, on a biological. Though the researchers point out that this 3D printed gel-based model still only predicts the behaviour of simple, regular brain structures at the onset of the gyrification process, it is nevertheless an important step towards eventually recreating more complex and dynamic emerging folds. The findings gathered from 3D printed brain model could potentially help understand and make early diagnoses for neurological disorders, such as Alzheimer's, through the identification of certain topological markers.[2]

It is believed that 3D printing could be the exact tool that researchers need to discover the cause of Alzheimer's disease and strokes and help to advance this research. Alzheimer's disease is an irreversible, progressive brain disorder that slowly destroys memory and thinking skills, and, eventually, the ability to carry out the simplest tasks. In most people with Alzheimer's, symptoms first appear in their mid-60s, as it is thought to begin 20 years or more before symptoms arise.

### **Biological data mining**

Biological data mining is a powerful tool that can provide a wealth of information about patterns of genetic and genomic biomarkers of health and disease. In 2015, the study "The role of visualization and 3-D printing in biological data mining" showed that 3-D printing has an important role to play as a visualization technology in biological data mining. As this study suggests, "The scientific community in particular is constantly trying to find new, creative ways to more easily and accessibly organize and interpret scientific data. A data set may remain unchanged, but the number of ways in which data can be displayed, viewed, represented, and subsequently interpreted are virtually limitless. It is through the application of this multimodal analysis process that we are able to gain a well-rounded understanding of the information that we wish to understand". The bio-data from a case of late onset Alzheimer's disease was used to create a 3D printed model that represented the condition's genetic interaction network. The study concluded that "The physical 3-D gene-gene interaction network provided an easily manipulated, intuitive and creative way to visualize the synergistic relationships between the genetic variants and grey matter density in patients with late onset Alzheimer's disease". These findings produced by 3D printing technology, can unlock ideas and insights, which could prove beneficial in Alzheimer's Disease research by physically rendering bio-data sets. [3]



But also, 3D printing could be useful for the patients, that it is more connected with the goal of 3D4ELDERLY project, for example following the Reminiscence therapy.

Reminiscence therapy (mentioned in previous point) is a treatment that uses all the senses — sight, touch, taste, smell, and sound — to help individuals with dementia remember events, people and places from their past lives. As part of the therapy, care partners may use objects in various activities to help individuals with recall of memories. It was noticed that the mood, quality of life, social interaction, cognition, memory improved after the therapy. 3D printing technology comes very handy in creating physical models to help to stimulate Alzheimer's patients' memories. 3D printers are used to make recognizable replicas and small-scale models of objects that hold special meaning or significance to the person with dementia. The ability to place a printed miniature model of an Alzheimer patient's favourite childhood toy or their car in their hand makes a lot of impact on reminiscence therapy success. [4] Even it is possible to replace photos to 3D printing objects, to offer a better stimulation and also the chance to interact with the object

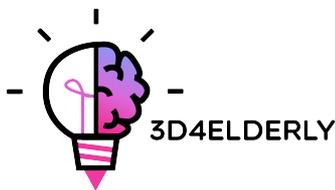
Also. there are a lot of objects and devices created with Additive Manufacturing that help people with Alzheimer and elderly people with dementia to better live their life. For example:

- A pocketable 3D printed GPS system to assist not only Alzheimer's patients, but also their families, in preventing patients from being lost or other games to help to stimulate Alzheimer's patients' memories.
- Also, to help them in structured their daily routine to prevent the loss of habits.

Game memory can play a significant role in an Alzheimer's patient's life because they can help them recall not just their present time and place, but also particular events from their history. While it remains to be seen what quantifiable differences 3D printing can make in understanding and treating Alzheimer's Disease, there appears to be a lot of evidence that the technology could help Alzheimer's researchers as well as Alzheimer's patients.

Finally, it is recommended to try to involve more 3D printing technology with Alzheimer due to the advantages of 3D printing related with the needs of people with Alzheimer and dementia:

- Possibility of customization of 3D printing objects. For people with 3D design skills, it is possible to customize existing designs, and, for example, let say to modify a chair and creating customized models of the same chair, for example engraving the name of the patient on it.
- Costs. Once you have the 3D printer, costs just are related to the material used for each piece, and obviously, your time. For FDM technology, materials are getting cheaper and cheaper.



- Versatility. Just the same machine can produce infinity of different pieces. And also different kind of sizes. Then it is easily possible to get pieces (with the very same machine) up to 20cm x 20cm x 20cm (as bigger as your machine), or just as tiny as 1cm x 1cm x 1cm.
- High quality and great detail. For people with Alzheimer and dementia it seems to be very important for the pieces to be very detailed, so they can easily recognise shapes, silhouettes, etc.
- Colours. Maybe it is a great idea to produce pieces fully colourful for people with Alzheimer and dementia. But most of technologies can produce pieces in just a single colour. Although there are some technologies that allow different colours in the very same piece, they are very expensive and non-affordable for everyone. But it is possible to paint pieces. How? You just have to print your model in white colour, then apply some post-processing such as sanded in order to erase the visible layers of the model and also to get more adhesion for paint. Also, it is possible to use some kind of resins for improving finishing and preparing piece for painting.

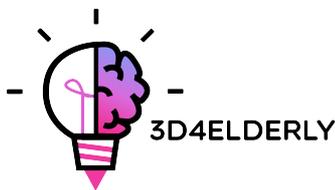
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## 9. Characteristics of tools to be used (colours, materials)

**Colours:** the colour preferences of people with dementia are deemed to be red, blue and green. Information on colour schemes for the manufacture of materials to be used for cognitive stimulation specifically is not available, therefore we base the review on research and recommendations made for the suggested living environment of the person with dementia.

The colour blue is known for its calming effect. Studies have demonstrated that using blue in the physical environment can actually lower blood pressure. It is also believed to be a good colour for dishes because it contrasts with food. If used as wall paint, due consideration should be given to the fact that blue visually increases the size of the room, but it also creates a feeling of coldness.



In order to attract the attention of a person with dementia, red colour should be used. It increases the activity of brain waves. A room painted in red visually reduces its size, but it is perceived as warmer. Red is also a good colour for plates and cutlery because it stimulates the appetite, attracts attention and also contrasts with food.

Green is a calming colour, a symbol of life and growth. It reduces the activity of the central nervous system and helps people remain calm. The use of green makes the rooms look bigger. In particular, lime green (light, bright – fluorescent) is effective in gaining the attention of people with AD or dementia and can be used for visual cues to signal bathrooms, bedrooms, walkers, etc.

The colour of pink suppresses aggression.

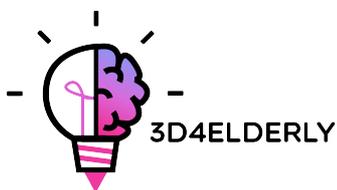
However, it all depends on the person with dementia. For example, the best practice guidelines for home design recommend a simple approach with moderate levels of environmental stimulation. Stimulating environments could improve the quality of life for some people with dementia. but others may find that such environment is overstimulating, disorienting, confusing and distracting.

Certainly, sharp contrasts of colours or patterns can be misinterpreted by people with dementia, who may have vision disorders and impaired perception of depth. Highly patterned surfaces (such as checked or repetitive) and lack of colour or texture contrast to distinguish between walls and floors can cause dizziness or confusion.

The best policy is to consult the person with dementia, if possible, when designing a change in the physical environment.

**Materials:** when selecting the materials to be used, the following important specifics should be taken into consideration:

- Possibility to be cleaned easily and quickly (always important, but especially at times of pandemic)
- Stability and strength of the product material and construction
- Materials and exercise items should be familiar to the person with dementia – earliest memories (youth, childhood) are the last to be lost
- Ensure comfortable temperature for the person with dementia when using the products. Some materials, especially metals, are exceptional conductors of heat and cold. People with dementia experience heightened sensitivity to hot and cold surfaces
- Sharp edges and objects that are too small should be avoided to make sure they are safe.



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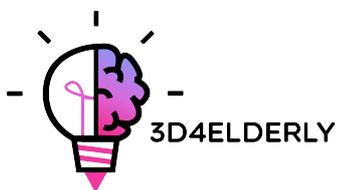
## **10. How to use 3D Printing in centres with people with Alzheimer and elderly people with dementia**

### **Introduction**

3D printing is the process of making three-dimensional solid objects from a digital file. It is an incredibly important invention used in many different fields, like construction, food, aviation, and healthcare. It is not uncommon nowadays to read news about scientific advances in the health department due to the help of 3D printing. Often, printed implants are experimental and part of still fringe technology, but that is not the case anymore. According to the article by P. D. Olson, over the last decade, more than 100,000 hip replacements have been 3D printed by GE Additive. It connects to the topic of Alzheimer's disease, which is an irreversible, progressive brain disorder that slowly destroys memory and thinking skills, and, eventually, the ability to carry out the simplest tasks. 3D bio-printing became an important part of scientific research of this disease. "By printing from real brain scans, we can see which areas of the brain are affected by dementia diseases such as Alzheimer's disease", comments Dr. Elizabeth Coulthard of the ReMemBr Group. For this reason, 3D printing is used in centres with people with Alzheimer's and elderly people with dementia. The use of 3D printing will help people by offering them a multisensory experience thanks to the tools created.

The University of Arkansas has collaborated with Methodist Village Senior Living centre to provide Alzheimer's residents with 3D-printed recreational items. Methodist Village is a not-for-profit organization, dedicated to enhancing the quality of life for the elderly population in the Arkansas River Valley. It also houses an Alzheimer's Centre, which includes various experiential centres for painting, gardening, fishing, cooking, and more. Each is designed to support memory care residents, with much consideration and thought given to the sensory items: "When planning for our Alzheimer's Special Care Community, we knew it was important to have the right sensory stimulation," explained Melissa Curry, the CEO of the organization.

To cater to these residents, Curry sought a partnership with of the University of Arkansas - Fort Smith. Contacting Dr. Ken Warden, dean of the UAFS College of Applied Science and Technology, Curry asked if the university could help produce a couple of sets of 3D printed nuts and bolts, reminiscent of work that the residents may recall from their youth. Dr. Ken



Warden said: "This 3D printing project highlights how our programs can work with outside constituents to educate our students while addressing a community need".

In Methodist Village Senior Living center, the new 3D printed sensory items have been received by the residents. Presented with newly printed nuts and bolts, Alzheimer's resident, who loved to 'fix' things and put them together, appeared captivated. "He was the first to use the nuts and bolts, immediately gravitating towards them, filling his pockets with them for later objects that may need fixing," added Melissa Curry. "These have already been an incredible blessing to him and will be too many others in the years to come".

Company "Moai Technologies" is creating improvements on 3D printing by developing and testing the feasibility of 3D printers to create realistic replicas and small-scale models of physical objects that reflect a meaningful facet of a person's past life. It could be a favorite toy or the family car. These objects are used as "aids" to help simulate reminiscing. This novel approach to the "personalization" of reminiscence therapy will result in better mental and physical health outcomes for individuals with dementia and the quality of the relationships they have with direct care staff will improve as well.

Research "Creating three-dimensional models of Alzheimer's disease" finds that each 3D-printed brain and hippocampus model takes approximately 25–35 h for segmentation and computer-aided design work. The cost of a model is approximately \$900 for printer use, materials, and post-processing.

In Europe, there are not many examples of using 3D print for Alzheimer's patients or elderly people with dementia. According to "Ricoh", a global provider of technology: "As the most common cause of dementia, Alzheimer's disease is well recognized, but other causes of dementia receive less public attention".

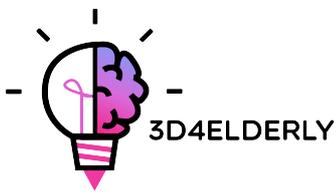
The Center for Psychotherapy and Psychoanalysis in Lithuania does not provide Alzheimer's patients and elderly people with activities related to 3D printing.

### **How to use**

In order to be able to use 3D printing in centres with people with Alzheimer and elderly people with dementia, there are 4 required things you will have to keep in mind: a 3D design, a 3D printer, the adequate material, and the knowledge to use all of them.

- Getting a 3D design:

If you need to print a photo or document with a 2D printer, it starts with a jpeg file, or a pdf file. For 3D printing, the same thing applies, you need to provide the software with a 3D model in STL format. Then, it will be converted into the GCODE the printer can read. There



are different ways for getting the 3D model. First one is to learn to draw in three dimensions (design the model by yourself). Simple software for that is 123 Design by Autodesk, or Fusion 360. Staying on free software, there is also Onshape and Blender. Software election will depend on the type of objects to be drawn.

There is also the possibility of downloading different 3D models in STL format ready to be used. That is called repositories, where you can freely download the digital model and you can also find some instructions to successfully printing the piece in your machine. The most famous a best organized is Thingiverse, in our opinion.

- Getting a 3D printer:

Once you have the 3D design, another important component to be able to print is the need for a recent computer, because you will need to install a slicer program, in addition to using it to create 3D drawings and designs. A slicer program is the development environment you will need in order to convert an STL file into the language the machine can interpret. Each 3D printer usually comes with a slicer program and there are also free options, like Ultimaker Cura.

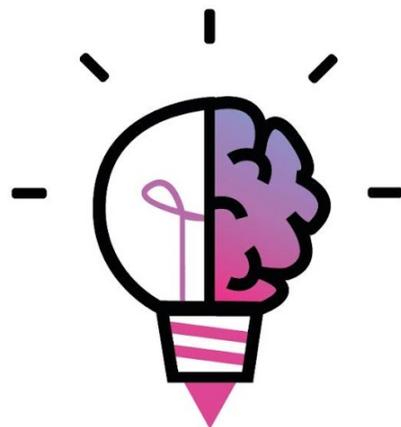
Then is time to look for the machine. Best option is to own a machine, so you can make the designs, try different models, make interactions, etc. If not, there are different possibilities, because there are companies, fablabs, online services, etc., that can 3D print for you. Companies specialized in 3D printing usually are more expensive than fablabs and online services, but also, since they are experts in the field, they can produce the best pieces. Online services are also a good choice, because it is possible to select the technology, material, upload the design, select the shipment, etc., and having the different prices of all the choices. Fablabs are Fabrication Laboratories. They are spaces open to public to, in this case, printing pieces and using the machines. In these laboratories, there are usually people expert in the field in order to help you with your project. In some case they will charge you for using the services, but in some cases, it is possible to use the machines freely. Check the national network of fablabs in your country!

- Getting the adequate material

To get the appropriate material for your prints is as easy as knowing the technology you are using for printing, and also the machine. As part of the 3D4ELDERLY project, you will find chapters in which materials according to technologies are fully explained.

- 3D printing knowledge

Finally, you will need to have the knowledge to put all the previous things all together. For that, you will find some chapters in which all the steps for, starting from a 3D digital model file, make your physical pieces come true.



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