



# Scenario-based Co-design with Older Adults: A Design Case on Decreasing Loneliness

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In many developed countries, the number of older adults is increasing. Many of them suffer from loneliness, causing mental and physical health challenges. Technological innovations offer the potential to address such challenges. However, a mismatch between user needs and intervention design often leads to abandoning technology. Therefore, we propose a multi-stakeholder scenario-based co-design approach to design a desirable technological solution for and with older adults. To develop in-depth and relatable scenarios, we extended the methodology with dilemma-driven design and the NADI (Needs and Aspirations for Design and Innovation) model. The approach was tested in a case study involving 80 older adults and 20 geriatric experts and industry partners using an iterative design method with four phases. We found that implementing such an approach allows older adults to overcome taboos and express themselves freely. The transdisciplinary collaboration has led to increased empathy and unexpected ideas based on the needs and wishes of older adults. The incorporation of dilemma-driven design and the NADI model offered clarity in translating the gathered information into effective scenarios. In conclusion, the implementation of a multi-stakeholder scenario-based co-design approach offers the potential to design suitable solutions for older adults suffering from complex societal challenges.

**Keywords** – Co-design with Older Adults, Design for Elders, Remote Co-design, Scenario-based Design, Transdisciplinarity.

**Relevance to Design Practice** – Older adults are an increasingly relevant target group with specific needs and wishes. To address their needs, it does not suffice to only apply human-centered design. The involvement of a multi-stakeholder group in which they become the leading actor is desired. This can be provided by employing the approach presented in this paper.

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## Introduction

Developed countries' populations are aging because of low fertility rates and increasing life expectancy (Lanzieri, 2013). This leads to a growing group of older adults in many developed countries. Many older adults tend to suffer from mental health issues as they experience significant losses in short time frames. Generally, older adults experience both bereavement of their loved ones and the loss of physical abilities (Van Tilburg, 2019). Such life events can contribute to increased loneliness.

The gravity of loneliness is severe. In the Netherlands, a majority of 54% of older adults (75+) feel lonely with an increasing trend as they age (VZInfo, 2023). The number of lonely older adults aged 75 and older is expected to increase from 600,000 to 1.3 million in 2040. This means that half of all people aged 75 and older experience loneliness (Rijksinstituut voor Volksgezondheid en Milieu, 2018). Furthermore, a recent study with Dutch older adults showed that the effects of the COVID-19 pandemic caused them to feel 34% lonelier than before (Van Tilburg et al., 2020). This has huge effects on our healthcare system, as loneliness is associated with increased morbidity and increased healthcare costs (Meisters et al., 2021).

In recent years, eHealth technologies have emerged as a promising avenue for supporting older adults in overcoming loneliness (Chen & Schulz, 2016). Products, such as

ambient-assisted living devices, apps or wearables, can monitor and coach older adults to overcome mental challenges (Rashidi & Mihailidis, 2013; Sumathy et al., 2021). One example is PACO, a dialogue-based conversational agent that supports older adults in their endeavor to change their dietary behavior and reduce feelings of loneliness (Kramer et al., 2021). Through such technologies, older adults can benefit from targeted interventions that address the root causes of loneliness, enhance social connectedness, and promote positive mental health and well-being.

One key advantage of eHealth technologies is their ability to provide personalized and tailored interventions that meet older adults' unique needs and preferences. For example, wearable devices can track physical activity levels, monitor sleep quality, and provide feedback and recommendations to help older adults maintain healthy habits and routines. Mobile apps and eHealth services can connect older adults with healthcare providers and

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social support networks, enabling them to stay connected and engaged with their communities despite physical distance or mobility limitations. Ambient-assisted living technologies can facilitate the creation of a safe and supportive living environment with features such as fall detection, home automation, and remote monitoring. However, it is important to note that careful consideration must be given to the design and implementation of these technologies to ensure they are accessible, user-friendly, and effective in addressing older adults' diverse needs and preferences. The reason is that many products designed for older adults do not satisfy their needs and are therefore abandoned (Heinz et al., 2012; Vaportzis et al., 2017).

One potential reason for technology abandonment by older adults is that it is difficult to get insight into what older adults really need, as open discussions about mental or physical health problems with older adults are still challenging (Conner et al., 2010; Sirey et al., 2014). A study with 162 older adults found that psychological openness was lower in older age (Kessler et al., 2014). Psychological openness refers to the *openness to acknowledging psychological problems* (Kessler et al., 2014). Shame and guilt of feelings of inadequacy might prevent older adults from being open. Without *psychological openness* due to social desirability bias, traditional research methods such as interviews may be less effective when determining older adults' needs and wishes (Bergen & Labonté, 2019). Therefore, the design mismatches with what the older adults actually want.

Another reason for this technology mismatch is the type and level of involvement of older adults and other stakeholders, such as industrial partners and geriatric experts in the design

process. It has been established that the involvement of several stakeholders benefits the product design process (Memon et al., 2014; Queirós et al., 2013). Especially involving the user is considered valuable as they can communicate their needs and wishes (Sanders & Stapper, 2008).

However, developing a shared understanding and treating the older adult as a partner in the design process requires the designer to create a level playing field in which older adults and other stakeholders can collaborate to develop an attractive solution. An approach to creating a level playing field is scenario-based design (SBD; Anggreeni & van der Voort, 2008). We hypothesize that SBD can address the issue of overcoming a lack of openness in older adults on the one hand and the lack of a level playing field between stakeholders on the other hand.

### Scenario-Based Design (SBD)

SBD has been found to potentially lead to a more impactful outcome of the design process (Anggreeni & van der Voort, 2008; Van der Bijl-Brouwer & van der Voort, 2014). The choice of SBD as a framework for product or service design means using scenarios as a communication tool. A scenario is "a process-description tool, [...] which uses concrete narratives to discuss and analyze how the technology fits into people's activities" (Anggreeni, 2010, p. 9). Following the process proposed by Anggreeni and van der Voort, it contains six kinds of scenarios:

1. **Explorative scenarios** provide a summary of different potential user stories originating from desk research.
2. **Actual practice scenarios** reflect real user stories that either confirm, reject, or refine the previous exploratory scenarios.
3. **Future practice scenarios** focus on the change of situation brought about by a functionality rather than the functionality itself. They serve as a foundation for formulating requirements.
4. **(Detailed) Interaction scenarios** provide clarity about how the potential solution is utilized by its target group, e.g., in combination with a lo-fi prototype.
5. **Problem scenarios** explore potential product failures and serve as a reference for testing the product or service.
6. **Validation scenarios** incorporate user goals and the context in which the product will be used. It serves as a checklist to determine whether the product fulfills all the previously set requirements.

The explorative scenario is defined by the researcher or designer and matures sequentially into actual, future, (detailed) interaction, problem, and validation scenarios through incorporating new knowledge gained in the product development process in collaboration with the users and other stakeholders. Through this, SBD offers two advantages in designing for and with older adults and addresses the challenges we previously described.

First, storytelling is a concept familiar to almost everyone. Therefore, the different scenarios in SBD facilitate clear communication with stakeholders by utilizing a typical frame of reference as scenarios evolve throughout the process (Anggreeni & van der Voort, 2008). Second, research findings are expressed in terms of user experience. This also means that feelings and ideas

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can be communicated through fictional narration without referring to personal experiences. This might create a safer environment for older adults to share their thoughts on a sensitive topic based on a persona, leading to realistic user needs that can inform a product design that older adults do want to use.

Furthermore, SBD is a framework with openness to include other methods. To be most effective, SBD requires scenarios to be developed in collaboration with potential users (Anggreeni & van der Voort, 2008). To do so, it is advised to employ participatory design approaches such as co-design (Culén & Bratteteig, 2013; Iacono & Marti, 2014; Müller et al., 2015). Co-design allows latent and tacit knowledge to surface, i.e., what people know, feel, and dream (Sanders & Stappes, 2008). The reason is that users are considered experts of their own experience (Sanders et al., 2010), whose expertise can be captured through co-design.

Although SBD is considered a useful framework to design despite psychological openness in users, Hanna and Ashby (2016) critiqued traditional scenarios as lacking depth and failing in their emotional appeal to the audience due to the absence of narrative tensions and elements of surprise. As a result, they were unable to offer readers any rewards. To address this gap, we hypothesize that adding dilemma-driven design (Ozkaramanli et al., 2017b) and the NADI model (Van der Bijl-Brouwer & Dorst, 2017) to SBD could facilitate the development of relatable scenarios.

### Dilemma-Driven Design

Dilemma-driven design offers a framework to capture emotional conflicts, provide insight into users' challenges during decision-making processes, and prioritize conflicting goals (Ozkaramanli et al., 2017b). It also facilitates empathy because it clarifies the thought process of users. It provides designers with a richer understanding of the target group. Therefore, dilemma-driven design allows designers to develop scenarios with richer emotional depth and clarity. Ozkaramanli et al. argue that dilemmas should consist of (1) mutually exclusive choices, (2) conflicting goals, and (3) mixed emotions (see Figure 1).

A relevant concern in dilemma driven design is the tension between long-term goals or satisfying immediate desires (Ozkaramanli et al., 2017b). This is interesting as it has been found that older adults tend to give in to short-term pleasures compromising, e.g., their health (Zantinge et al., 2011), dilemma-driven design offers a suitable framework to establish a deeper understanding of the reasons for such behavior by taking the mixed emotions into account.

Dilemmas enable creativity in exploring the solution space, as there are multiple approaches to design for dilemmas. Examples are resolving dilemmas, moderating dilemmas, or triggering dilemmas (Ozkaramanli et al., 2017a). Consequently, dilemma-driven design is a suitable approach for formulating scenarios with a focus on the status quo, as they capture the essence of the challenges people are facing. They help identify users' personal dilemmas and reasons for their choices, which may trigger a product idea catering to the needs to solve their struggle, e.g., loneliness.

### NADI-Model

The NADI (Needs and Aspirations for Design and Innovation) model promotes awareness of various depths of human needs and aspirations, and how they impact design and innovation processes (Van der Bijl-Brouwer & Dorst, 2017). It identifies four levels of depth in insights driving design and innovation. The top solutions level describes the desired types of solutions. The second scenario level outlines how people want to interact with solutions in specific situations. The third goal level details the objectives people want to achieve with a solution within the context of the design problem. The deepest theme level describes aspirations or needs beyond the context of the problem. Themes, derived from phenomenology, are stable constructs shared by many people and can be explored independently of the problem.

The NADI model can be employed to better comprehend the insights gathered through various design research methods and how these insights affect the design and innovation process. Dorst (2015) demonstrated that analyzing themes supports problem reframing and radical innovation. It can be used to extract the essence of research findings that form the foundation for formulating insightful scenarios in SBD.

### Research Goal

In sum, the goal of this paper is first to investigate whether we can co-design for a complex societal challenge (i.e., loneliness of older adults) by using a stakeholder-centered scenario-based approach. Second, we want to explore how to enrich existing scenario-based design approaches with dilemma-driven design and the NADI-model. We do this by presenting a case study that focused on developing technological solutions to promote social cohesion a healthy lifestyle.

### Method

The scenario-based design framework was applied to a case study in the context of the European research project Pharaon (for details, please visit <https://pharaon.eu/>). Pharaon intends to launch pilots to promote healthy and active aging in five countries using eHealth technologies. The presented case study was conducted in the context of a pilot with focus on countering loneliness. It consisted of four iterations. The target group are users of a national initiative from local communities around the Netherlands. Their service organizes a variety of trips that older adults can sign up for. Many of their users suffer from loneliness.

Several stakeholders of the Dutch pilot were involved: researchers, technology and service providers, research partners, as well as target users (i.e., adults aged 65 years and older). Each stakeholder group was involved in a different phase. First, older adults were involved in the development of actual and future practice scenarios, as they are the only ones who can explain how they currently live and how they would want to live their lives in the future. Industry experts were involved in defining interaction scenarios as they were the ones with the expertise of their technological possibilities and limitations. Lastly, an older and a

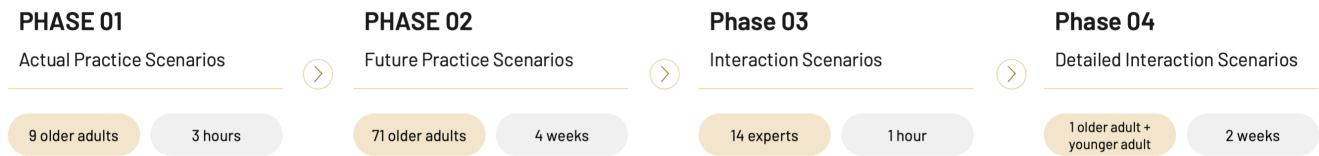


Figure 1. Visualization of stakeholder relation and scenarios.

younger adult defined the detailed interaction scenario to confirm or reject aspects of what the industry experts proposed according to their personal experiences. While each phase used a different approach, one part of the method was the same for each stakeholder group: the research activity was introduced with a scenario, and they were asked to develop a more detailed scenario for the next phase. A more detailed overview of the process can be seen in Figure 1.

### Phase 1: Actual Practice Scenarios

#### Overview

In the first phase, we aimed to gain insights into user concerns related to loneliness and overall well-being through actual practice scenarios. This was done in a co-design workshop with older adults. Prior to the workshop, a pilot was conducted with two older adults (female, 63; male, 72). Changes to the initial process have been implemented according to their feedback.

#### Participants

The workshop was conducted with nine older adults. Seven were frequent users of a local social community service (5 female and 2 male participants; aged between 81 and 88, mean age 84) recruited by the treasurer (male, 73) of the organization, who also participated in the session with a second volunteer, the person who scheduled the trips (female, 64). It was chosen only to include older adults, as they are the only ones who can provide us with an accurate image of their current experiences.

#### Protocol

The workshop topic did not revolve around loneliness but focused on the participants' general well-being. The session was divided into four sections, scaffolding the level of required creativity according to Sanders and Stappers (2008). The sections are probe, prime, understand and generate (see Figure 2).

After a moment to socialize and get to know each other with name tags, an introduction round, coffee and cake, participants received a poster with four topics: food, movement, social contact, and activities outside the house. The poster required participants to describe their habits in terms of the four categories by placing sticky notes on the different sections. The activity is based on context mapping (Visser et al., 2005) and focuses on raising participants' awareness of their current behavior in preparation for the subsequent activities. After sharing their results in a plenary setting, the participants received a second poster with instructions to write down what they would like to change about their current habits. They were encouraged to discuss this with their neighboring participants. The session concluded with the exercise to write a fictitious story that facilitates the transition from their current to their improved day as described on their posters. For that purpose, participants were divided into four groups, each focusing their stories on one of the topics.

The process was documented with three audio-recording devices, researcher notes, as well as the posters and stories of each participant. The results were then translated into actual-practice scenarios using the dilemma-driven design framework (Ozkaramanli et al., 2017b) and three personas according to the approach of Nielsen (2019) by the first author based on the information collected in the co-design workshop. The persona who will be used as an example in this paper is Lisette, a 68-year-old housewife.

### Phase 2: Future Practice Scenarios

#### Overview

The aim of the second workshop was to create future practice scenarios that provide insight in the desires of older adults in relation to loneliness based on the dilemmas of the actual practice scenarios in phase one. However, due to the effects of COVID-19, a traditional co-design session with methods such as role-playing or rapid prototyping was not feasible. Therefore,

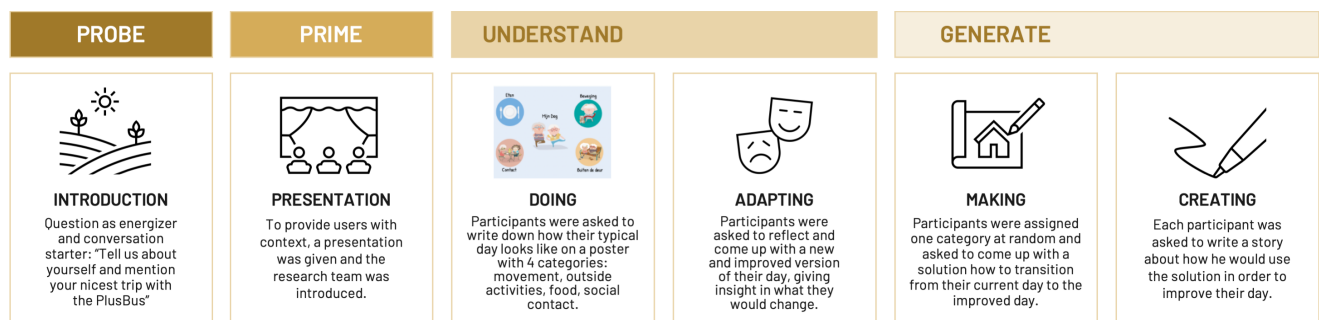


Figure 2. Process overview of co-design sessions (Sanders & Stappers, 2008; Sanders et al., 2010).

a remote asynchronous generative session in the form an open call of submissions from newspaper readers was organized in collaboration with the local newspaper. In consultation with the editor in chief and the journalist, an execution plan was developed. The collaboration was approved by the ethical commission of the University (RP 2020-50).

### Participants

All readers of the newspaper were invited to participate. This newspaper has a large reader population among older adults. It was also reflected by the submissions we received. From 71 participants, the most senior participant was 88 years old; the youngest was 31, and the mean age was 64.1.

### Protocol

The open call for submissions was presented in a series of three newspapers (see Figure 3). The first newspaper edition announced the study on the title page and used a spread within the newspaper to provide in-depth information. It comprised an editorial about late-life loneliness, a presentation of three fictional dilemmas, as well as a call-to-action to submit solutions for the presented dilemmas through an online form, e-mail, or letter. The second newspaper edition was released one week later and contained interviews with two participants and repeated the previous call-to-action to collect more responses. The last newspaper edition was released a month later, and it provided an overview of outcomes and comments by the researcher, portraits of participants who indicated an interest in a follow-up interview, and a closing statement.

The intention of the open call was to start a call-to-action in the newspaper for ideas how to overcome loneliness based on three actual practice scenarios as developed in the previous phase.

We chose to continue with three instead of all eight to support the readers to choose one focus. The selection of the three actual practice scenarios was made using the choosing a design-worthy dilemma framework by Ozkaramanli et al. (2017a).

Readers were instructed to familiarize themselves with the three dilemmas. Then, they were invited to write their own stories about how they would help the personas presented in the dilemmas. The method is based on a co-design fiction approach (Ambe et al., 2019). According to Knutz et al. (2016), actively involving participants using design fiction enhances outcomes as it (1) *stimulate[s] critical and humorous reflection*, (2) *increase[s] multi-stakeholder collaboration*, (3) *allows engage[ment] with “deep characters”*, and (4) *root[s] the unfamiliar in a real-life context*.

In the instructions, readers were encouraged to be creative with their stories. Therefore, they were allowed to use their medium of preference to develop a narrative, be it text, visuals, or an audio file. The material was analyzed according to the NADI-model (Van der Bijl-Brouwer & Dorst, 2017) in which we identify potential solutions, scenarios, goals, and themes. This model was chosen as we were provided with solutions to a problem and had to understand the underlying intention of the solution. It allowed us to structure the results and understand the underlying design requirements. Submissions were then translated into future-practice scenarios, which will be further elaborated on in the results section.

### Phase 3: Interaction Scenarios

#### Overview

The goal of the third phase was to come up with initial design concepts in collaboration with industry experts ( $n = 11$ ) and engineers ( $n = 3$ ) based on the previously developed actual and

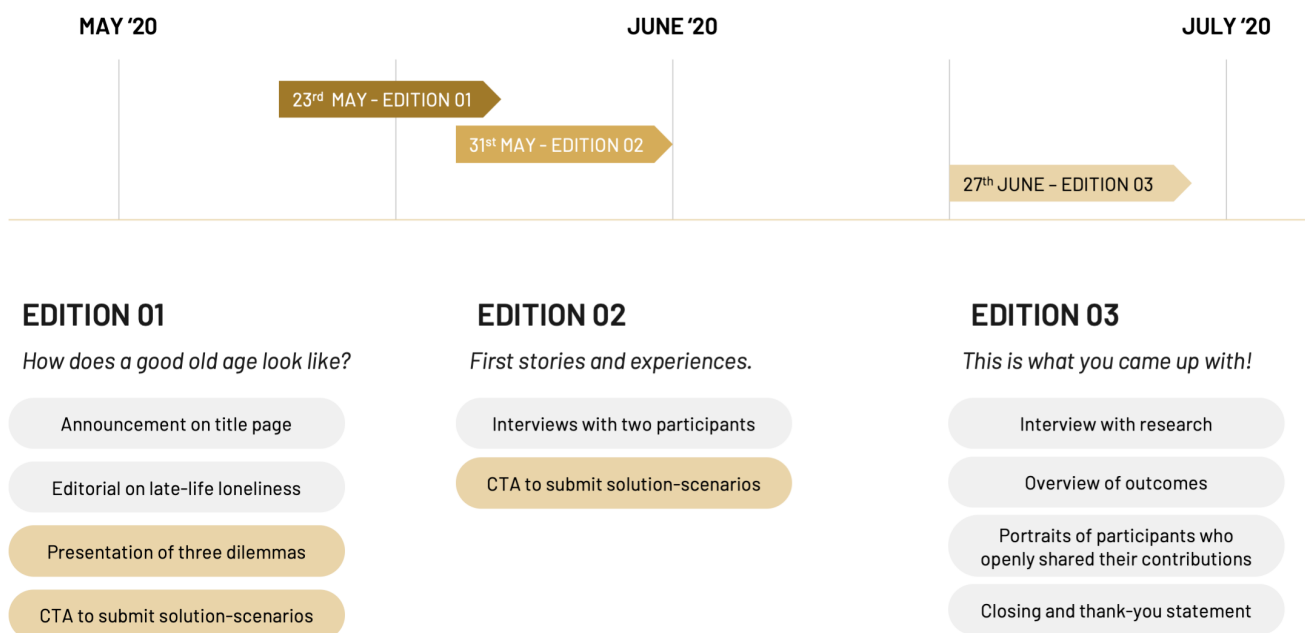


Figure 3. An overview of the steps taken to conduct a co-design fiction study using the local newspaper.

future practice scenarios. The actual and future practice scenarios specify the challenges that older adults face in relation to loneliness, as well as what they expect from a solution. However, to translate this into a feasible design, we require the expertise of those who will develop it. Therefore, two solution-oriented ideation workshops were setup to develop concrete interaction scenarios.

### Participants

The participants of the first workshop were industry experts ( $n = 11$ ) involved in the research project. They are either technical partners ( $n = 8$ ) with focus on developing products for older adults or social innovation employees at a Foundation for Elderly ( $n = 3$ ). The participants of the second workshop were three Industrial Design Engineers with extensive knowledge on scenario-based and human-centered design approaches ( $n = 3$ ).

### Protocol

Due to COVID-19, the ideation workshops were translated to an online setting. Prior to the workshop, the industry experts and engineers were sensitized in order to empathize with older adults (Kouprie & Visser, 2009) by introducing them to the scenarios and personas created in prior phases. This helped participants to gain a deeper user understanding stimulating them to develop user-centered interaction scenarios. In extensive brainstorm sessions, several ideas were developed using design thinking approaches. Both followed a similar process.

The brainstorm session lasted one hour and involved three steps, which were (1) sensitizing, (2) brainstorming, and (3) prioritization. The first 15 minutes, participants were asked what they learned about the personas and what this could mean for potential solutions. It reminded them about the challenges and activated their creativity for the actual brainstorm. After that, participants used 20 minutes to brainstorm about potential solutions. In the third step, each participant was asked to select three favorite ideas and place them on a *how-now-wow*-matrix (Zakrzewski et al., 2019), which categorizes the creativity and feasibility of each solution. Participants were asked to motivate their choices. The session ended with a plenary vote on the most appealing ideas. The first author formulated the three most appealing ideas into interaction scenarios according to the future practice scenarios and technological descriptions provided by the experts.

## Phase 4: Detailed Interaction Scenario

### Overview

Phase four of the design process aimed to enrich the interaction scenario based on actual experiences and to formulate a detailed interaction scenario. The chosen interaction scenario was a lamp that represents a social presence in the home of older adults and can only be activated by a loved one. The co-design activity involved a technology probe (Hutchinson et al., 2003) to understand pain points as well as opportunities of this interaction scenario, accompanied by a probing kit to document thoughts and ideas.

### Participants

In this co-design activity, younger and older adults with an intimate relationship must form a pair to execute it. Therefore, the activity was conducted with a mother (61) and her son (23).

### Protocol

Participants received a technology probe and several tasks to document personal interpretations and ideas. The narrative involved that the older adults were given the awareness system by the younger adults, who decided to return it after being dissatisfied with the functions. It follows the co-design fiction approach described by Huusko et al. (2018), who used a narrative to set the scene of her co-design session. Overall, the activity lasted two weeks and involved four steps: using a technology probe, documenting the experience, reflecting, and providing recommendations. The different steps made the participants experts of their own experiences (Sanders et al., 2010) and allowed them to generate ideas based on their own wishes and desires that were left unfulfilled by the given prototype.

The older adults received the presence light, as well as a probing kit including a diary, inspiring images, stickers, glue, colored pencils, and a pen. Everything was packaged and presented in an appealing way in order to establish an emotional attachment to the lamp that was associated with the younger adults. A location for the lamp was chosen and it was installed by the son according to a set of instructions. The instructions described the product as an awareness system and included a return-sticker as well as space for reasons why the users were dissatisfied with it and how it can be improved.

The mother received the light, while the son installed an application on their phone allowing for remote control. This means that the older adults could not respond to the changes in the lamp, and that the younger adults did not receive any feedback from the older adults, leading to an asymmetrical distribution of interaction possibilities. By providing the participants with such a limited version of an awareness system, it allows them to recognize pain points and opportunities for improvement. These were to be documented in the accompanying journal.

## Results of the Four Phases

In this section, we summarize the results of the four iterations, showing how the scenarios were translated from one phase to the other.

### Phase 1: Actual Practice Scenarios

A total of 9 participants (older adults) took part in the workshop and generated posters and stories with their experiences. To analyze the collected material, a thematic analysis (Braun & Clarke, 2012) based on quotes from their posters, stories, and conversations was conducted, providing insight in their habits, thoughts, and feelings (see Figure 4). The identified themes were hobbies, mobility, independence, nutrition, vacation, grief,

friends and family, methods of contact, and barriers for social connection. For instance, many older adults indicated that they want to maintain their independence and emphasize that they can cope alone, so they do not reach out to other people when facing difficulties. Also, loss plays an important role in feelings of loneliness, which manifests itself in grief due to the bereavement of their partner, loss of mobility, and loss of financial stability. Furthermore, many engage in hobbies or travel that reinforce their preferred social identity, e.g., by participating in the church choir or Thai-Chi courses. However, it also showed that older adults used e-Mail and WhatsApp to stay in touch with their loved ones, which means that many possess a certain extent of digital literacy.

Looking at concrete quotes within these themes, one can formulate specific challenges that older adults face using dilemma-driven design (Ozkaramanli et al., 2017b). The following eight dilemmas were identified that summarized the main takeaways of the co-design session:

1. I lost my partner, so I feel alone but do not want to bother the people I love.

2. I want to mingle with other people, but I need to stay within my body limit.
3. I don't want to confirm the stigma of ageism, even if I do need help sometimes.
4. I want to make the most out of my life, but I cannot bother with changing my routine after all this time.
5. I want to enjoy activities while I can still walk, but I am scared to reach my limit in an unknown environment.
6. I want to interact with my neighbors, but I fear being rejected.
7. I want to make friends, but I don't think people will like me without my partner anymore.
8. I want to invest in my well-being, but I do not want to waste money.

Through dilemma-driven design, the collected data could be synthesized and applied to an actual practice scenario in such a way that it added a layer of depth in terms of feelings and personal goals. For an impression of such an exact practice scenario, please refer to the example below (see Figure 5).



Figure 4. An overview of the thematic analysis with the quotes collected during the workshop.

**Example Actual practice scenario:**

*“I lost my partner, so I feel alone but do not want to bother the people I love.”*

Lisette is a 75-year-old retired cashier who lives in a small apartment in a larger complex mainly for elderly. She was married for 45 years but three years ago she lost her husband, which is why she lives by herself now. To deal with the grief, she moved out of their house to be in an environment with likeminded people. At the apartment complex, she has made herself quite some friends already. Today, Lisette and her acquaintances went to an arts class, where they recreated famous paintings. She used to paint a lot in her younger days, so her work stood out from the rest.

Very satisfied with her work, she was proud to share it with her beloved ones. She came home but the apartment was empty. She could call her daughter, but she did not want to bother her at work. So, Lisette kept it to herself and looked at the clock. It was five already, so Lisette goes into the kitchen to cook. She decided to make a pumpkin soup. But as she cooks, sadness overcomes her. She immensely enjoyed the arts class, but after being exposed to social contact and coming home to no one, she feels especially lonely.

She looks at an image of her late husband and sighs. She would have liked to tell him about the fun she had with the other ladies. She would have loved to show him her painting. It does not matter how many friends you have if at the end of the day, you are by yourself again, with your own thoughts and no one to share them with.



Figure 5. Persona Lisette in the dilemma-driven-design framework by Ozkaramanli et al. (2017b).

**Phase 2: Future Practice Scenarios**

In phase 2, the actual practice-scenarios were used as inspiration to come up with future-practice scenarios. This was done through a call-to-action in the local newspaper. In total 71 submissions were collected. The submissions were varied, including extensive personal stories and short suggestions for potential solutions. It follows the NADI-model, in which we identify potential solutions, scenarios, goals and themes in collaboration with the participants (van der Bijl-Brouwer & Dorst, 2017). First, the submissions provided insight in the desired solutions and scenarios. This was done by summarizing the submissions in 240 essential quotes (translated from Dutch). Then, the quotes were categorized based on eight goals spread amongst 39 subcategories. The goals and their subcategories were:

1. **Interaction:** Need for physical contact, meeting like-minded people, no influence of status, shrinking network, wanting to be involved with young people, need to improve social skills, need for conversations, variety of communication channels, joint activities.
2. **Sharing stories:** Having someone with an open ear, sharing images, sharing stories, writing for yourself, cultural barriers for sharing stories with others.
3. **Selfcare:** Physical activity, nutrition.

4. **Overcome shame:** Asking for information, being confident, being independent, establishing trust, old means being lonely and needing help.
5. **Passion:** Find your identity, have hobbies, and fill your free time.
6. **Architecture:** Facilities, shared living spaces.
7. **Feeling useful:** Being included in society, maintaining structure, teaching what you know, learning, volunteering, and taking responsibility.
8. **Technology:** Simplicity, social robot, learning, services, and virtual travel.

In order to translate the goals into user needs for product development, themes were assigned to each subcategory. Themes indicate the motivation behind the respective goal to extract the actual user need (van der Bijl-Brouwer & Dorst, 2017). After that, the different themes were clustered into five value groups that formed the basis for five future-practice scenarios. The theme clusters constitute multiple values that enhance and complement each other:

1. **Contribution:** Older adults want to be part of society and contribute to show their capability and reliance.
2. **Support:** Older adults require a deep emotional bond fueled by compassion, empathy, and trustworthiness. They want to be with their family, feel secure, and return to earlier times



when you had a more community-oriented society rather than individual-oriented. Also, they want it to be through traditional media rather than technological solutions.

3. **Belonging:** Older adults want to feel a sense of belonging and be part of a community, in which everybody is equal independent of social status and cultural background.
4. **Active life:** Older adults experience major losses which changes their day drastically. Therefore, they need to engage in activities that provide them with a new routine and rhythm.
5. **Openness:** Older adults need to engage in new activities and learn about new things to stay in touch with society and meet like-minded people.

The future-practice scenarios were written by the first author using each cluster to describe one desired solution as a response to the challenges formulated in the actual practice scenarios, see below for an example of the cluster *support*.

While future practice scenarios illustrate the expectations and wishes described by older adults, they do not offer a direct method for evaluating ideas. Therefore, quotes from the future-practice scenarios were used to formulate specific *intended experiences* in relation to the theme they are based on. This allowed us to measure whether an idea effectively fulfills the user need formulated in the future-practice scenario.

The table shows the *quote*, the *intended experience*, and the *theme requirement* that is based on the five themes described before. Through this, the table provides a fast and neutral comparison of interaction scenarios and user needs. Table 1 offers an extract of the whole table and shows the intended experience of the theme *Support*, based on theme requirements such as trustworthiness, empathy, and security.

### Phase 3: Interaction Scenarios

The goal of phase 3 was to develop initial design concepts in collaboration with industry experts ( $n = 11$ ) and engineers ( $n = 3$ ) based on the previously developed actual and future practice scenarios. This resulted in three concepts:

1. **Community platform:** A platform that supports older adults to connect with others based on shared interests or participating in activities facilitated by local community centers. Afterwards, older adults are invited to document their own experiences during those activities and share them with family or other participants.

2. **Presence light:** The presence light is a lamp that conveys the feeling of presence of another person without being in the same room. The light can only be turned on by the other person. The exact meaning of the light can be determined by the users, e.g., “call me” or “I am thinking about you”.
3. **Pen pals:** In the future practice scenarios, several older adults expressed a desire to share their stories with others or want to have a deep exchange with a peer. ‘Pen Pals’ utilizes handwritten letters to communicate. It combines digital and analogue elements effectively, as it translates the written letter to a digital version that is printed at the addressee’s home.

These three ideas were further specified as interaction scenarios explaining the concept in more detail from a user-centered perspective. The idea was further elaborated on and translated into a narrative in collaboration with industry experts and engineers. Each narrative related to one of the three actual design scenarios (Phase 2) and provided a solution to the described dilemma. To understand which interaction scenario catered to the needs of the older adults best, the interaction scenarios were compared with the user needs established in the previous co-design activity (see Table 1). While a concept does not need to fulfill all user needs, as loneliness is a complex challenge and must be addressed through different channels, the most effective solution can still be determined. This way, a solution was chosen objectively, which in this case was *the presence light* (see example interaction scenario on next page).

### Phase 4: Detailed Interaction Scenarios

Two participants, a mother (61) and her son (23), participated in phase 4 and tested the first prototype of the presence light. It became apparent that they both perceived the experience as positive and felt more connected to each other. The son emphasized: “I am thinking much more often about my mother.” However, he admitted that he forgot to turn on the lamp a few times, which made him feel guilty. Nonetheless, “I liked to be able to send her messages and was excited to see how she responded.” Their journals indicated that she either called or sent a WhatsApp message to react to the lamp. While there was great engagement in the beginning, it became less after four days. On those days, the mother was visited by her sister, and they spent their time mostly outside.

**Table 1. An extract of the whole table with four out of 18 user needs.**

#	Quote	Intended experience	Theme Requirement
4	The solution allows Lisette to speak with someone she trusts about sensitive matters.	Offer a safe space for discussing sensitive matters.	Trustworthiness
5	She feels that her family is empathic and provides her with support.	Offer a reliable support system.	Empathy   Support
6	Lisette feels confident to use it because it is a traditional way of dealing with your problems that provides her with a feeling of security.	Design usability according to standards of older adults.	Traditionalism   Security
7	Thanks to this new solution, she feels much closer to her family now.	Strengthen the connection to their family.	Family-orientedness

### Interaction Scenario: "The Presence Light"

Lisette was incredibly happy when she opened the package she received from her daughter. The card in the package read: "I hope you like my present. Call me when you found a nice spot for it!". It was a lamp and it fit her apartment perfectly; simple, and modern. She placed it in the living room, on the table next to her armchair. She plugged it in and tried to turn it on but could not find the switch. "I think it is broken, let me call Eva", she mumbled as she grabbed her phone and dialed her number. Eva picked up and asked if she finally received the present she sent. "Yes, but I think it is broken. I cannot turn it on!", Lisette explained. "Just wait", Eva laughed, and Lisette's eyes widened as the light suddenly turned on. "How did you do this?", she asked her daughter, who explained that she is the one controlling the light: "Every time the light is on, you know I am thinking about you". Lisette smiled, she had such a thoughtful daughter, but she did not think that she really needed it: "You can also just call me, I would like that more", but her daughter insisted: "This way you can call me when it suits the both of us best. I do not want to call you every time I think about you. That would be too much. But I want to show you how much I care". Lisette was not yet convinced but accepted it. "It can do no harm", she thought.

The next day Lisette had painting class again and as promised, they started to paint "Starry Night" by van Gogh. Lisette enjoyed it and had a nice discussion with her friends on her way home. At her apartment, her positive aura disappeared as soon as she entered. She put her things down and got changed. With a big sigh she looked at the clock in her room and said: "Time for some food". While walking to the kitchen, she saw that the light in her living room was on. Suddenly, it started to flicker. Lisette was concerned and decided to give her daughter a call.

"I just wanted to make sure that you call me!", her daughter said. Lisette was relieved and laughed: "I thought something happened! Next time I will call you when the light is on. This reminds me of what happened today at painting class....". Lisette and Eva continued to discuss about her mother's painting class, allowing Lisette to get her thoughts off of her chest.

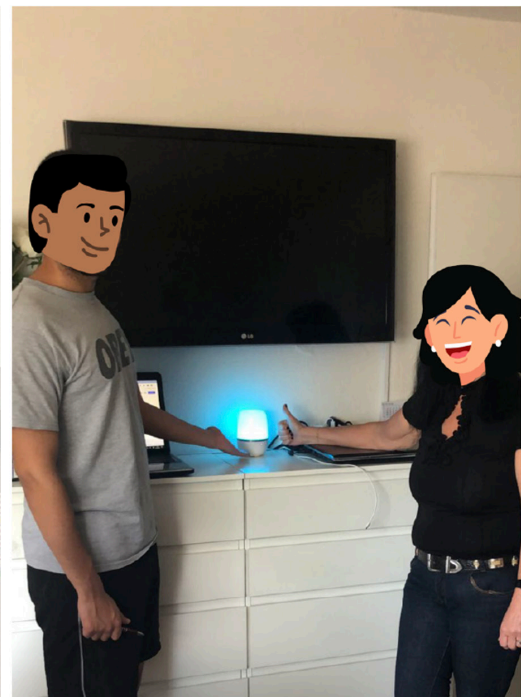


Figure 6. Contents of the probing kit including the technology probe. Right: Older adult and son with ibilight prototype.

The documented experience with the presence light showed that the technology probe fulfilled the task of increasing the feeling of connectedness between mother and son due to higher frequency in interaction (Markopoulos et al., 2003). However, this was due to the interaction with each other through other means (WhatsApp, phone calls) rather than the effect of social presence. The reason was that the technology probe only facilitated one-sided communication (son to mother), and the mother felt a responsibility to react. It was an unintended side-effect, which had positive aspects, i.e., increased connectedness. However, it also led to negative outcomes, such as a feeling of guilt and responsibility.

This means that the aspect of effortless and convenience must be honored to create a product that ensures consistent use (Chang et al., 2001; Dey & de Guzman, 2006; Keller et al., 2004; Markopoulos et al., 2003). The design implication is that a product must facilitate symmetric communication possibilities that do not require high effort to stay in touch (Markopoulos et al.).

To conclude this phase, the previous interaction scenario is improved and enriched with novel insights from phase 4. It gives more information about interaction possibilities and the thoughts and actions of potential users based on the feedback provided, such as adding symmetric communication possibilities.

### *Detailed Interaction Scenario: "Coming Home to Tell My Story"*

Lisette is a 75-year-old retired cashier who lives in a small apartment in a larger complex mainly for elderly. She was married for 45 years but three years ago she lost her husband, which is why she lives by herself now. To deal with the grief, she moved out of their house to be in an environment with likeminded people. At the apartment complex, she has made herself quite some friends already. Today, Lisette and her acquaintances went to an arts class, where they recreated famous paintings. She used to paint a lot in her younger days, so her work stood out from the rest.

Very satisfied with her work, she was proud to share it with her beloved ones. She came home but the apartment was empty. She could call her daughter, but she did not want to bother her at work. Instead, she went to squeeze her ibilight, to show her that she was thinking about her. It felt soft and vibrated slightly, to show that the message was sent to Eva. Lisette smiled; she loved her daughter a lot and wanted to show her. She looked at the clock, and saw it was five already. Time to cook. When she walked into the kitchen, she heard a sound coming from the lamp. She saw that the small LEDs turned on. "Ah, she saw that I thought about her", Lisette said as she went to cook.

When Lisette sat down in front of the TV to eat, the small LEDs of the lamp turned off and her phone rang. "Oh, it must be Eva!", she exclaimed as she grabbed the phone. "Hello, my dear", she answered. "Hey mom, how was your day?", Eva asked. Both talked while Eva was cooking dinner for her family. It was a brief conversation, but Lisette could tell her about her achievement. Of course, Eva wanted to see the artwork, so she turned on the camera. "Look what Oma made!", Eva got her little daughter on the phone as well. It felt nice.

"Ok, mom. We will eat now", Eva said. "Yes, go ahead, dear. Enjoy. I love you", Lisette ended the conversation and put the phone to the side to finish her own dinner. When she put the plate in the sink, it already got dark outside. She wanted to switch on the lights, but Eva already turned the presence light on. Lisette shook her head; she was so proud of her daughter. Juggling everything and even taking care of her so well: "She is amazing."

## Discussion

### Principal Findings

This study investigated the benefits of using a scenario-based design approach while including multiple stakeholders in a co-design process to address a complex societal challenge for a group with particular needs, i.e., lonely older adults. To do so, we conducted a case study with older adults and other stakeholders in an iterative design process following the SBD approach proposed by Anggreeni and van der Voort (2008).

Reflecting on this design case, we see that SBD is a powerful tool when applied to a complex and sensitive challenge such as loneliness amongst older adults. By enriching it with dilemma-driven design and the NADI-model, it facilitated a transdisciplinary collaboration of stakeholders who can make an impact to solve this societal problem. It offers opportunities for different stakeholders to empathize with depth and detail and allows people to participate and add their own unique ideas and experiences. Essentially, we could distil three benefits from this case study: It allows us to (1) create a level playing field between older adults and experts, (2) evoke empathy through rich scenarios, and (3) include a variety of perspectives.

### Creating a Level Playing Field between Older Adults and Experts

Considering the topic of loneliness, older adults often deploy regulative coping approaches without being fully aware of it (Schoenmakers et al., 2012). Even when becoming aware of their challenges, it does not mean that older adults feel confident or comfortable sharing challenges in relation to loneliness. Often, they want to present themselves as independent and strong (Goll et al., 2015). Our findings confirmed this in phase one, and that is in line with the notion that older adults have lower psychological openness (James & Buttle, 2008; Kessler et al., 2014). It became

apparent that asking participants about their personal challenges and experiences with loneliness only led to limited engagement with the activities. It might have been better to present them with explorative scenarios in which we captured first assumptions and findings from research to get a better image of the status quo, which leads to the actual practice scenarios.

The rise in quality of data collected when introducing a scenario first rather than asking for personal experiences, also becomes apparent in phase two. The co-design fiction activity showed that participants empathized with the fictional scenarios' personas and proposed solutions they would like to use themselves. With scenarios, participants are not required to make themselves vulnerable but can speak about someone else while elaborating on their personal perspective. They can identify with the presented personas (Nielsen, 2019) or explain why they are not relatable, i.e., scenarios and personas do not have to capture the situation perfectly but offer a platform for discussion to identify real challenges and opportunities. It establishes a common frame of reference, i.e., a shared language designers and older adults can use to communicate abstract concepts (Maaß & Buchmüller, 2018; Lindsay et al., 2012).

Essentially, scenarios create a level playing field between older adults, designers, and other stakeholders. Older adults do not have to make themselves vulnerable by describing their personal challenges openly. They move from being a subject to being a partner who investigates a sensitive situation with the researcher using their expertise. It becomes a relationship in which they see eye to eye since the designer or other stakeholders also do not share insights about their own challenges. Simultaneously, using fictive scenarios—short stories—to communicate concepts encourages older adults to share their solutions. The solution does not have to be perfect and does not need to be described in technical terms, since it is a narrative. Overall, we feel that our design process showed that scenarios can help to treat older adults as partners in designing a solution for a sensitive issue like loneliness.

## Evoking Empathy through Rich Scenarios

Since loneliness amongst older adults is a complex societal issue, it does not suffice to only involve potential users to develop a solution (Knapp et al., 2019). Other stakeholders must also be considered in the design process, such as, e.g., organizations, companies, industry, and governmental entities. Through their involvement the design of new technology does not only incorporate user needs, but also societal, economical, legal stakes, as well as technical and organizational feasibility. SBD facilitates such involvement as it offers a common frame of reference through scenarios that evolve throughout the process (Anggreani & van der Voort, 2008). In each phase, a scenario is used as input, and a more detailed scenario is created as output using the expertise of the stakeholders. The scenario is formulated in a language everyone can understand, independent of their educational background or technological knowledge. Research findings are expressed in terms of narratives, reflecting on aspects that the researcher and stakeholders consider relevant for the product developed.

However, involving non-users requires the scenarios to evoke empathy and sensitize the stakeholders in order to develop user-centered solutions (Kouprie & Visser, 2009). Considering that traditional scenarios (e.g., Fulton Suri & Marsh, 2000) were found to lack depth and therefore fail in their emotional appeal to the audience (Hanna & Ashby, 2016), we have extended the development of scenarios with dilemma-driven design (Ozkaramanli et al., 2017b) and the NADI model (Van der Bijl-Brouwer & Dorst, 2017). These design methodologies offer the potential for developing deep and relatable scenarios reflecting the challenges and goals of users.

Dilemma-driven design offers a suitable framework to establish a deeper understanding of the reasons for behavior that leads to loneliness by considering mixed emotions (Ozkaramanli et al., 2017b). It facilitates empathic design (Kouprie & Visser, 2009) because it clarifies the thought process of users. Similarly, the NADI model is not related to a specific product (Van der Bijl-Brouwer & Dorst, 2017). Instead, it provides a systemic approach to identify a deeper layer of particular user needs. This means the final design is not limited by functionalities but by user goals formulated regarding themes. This makes it an effective tool for extracting user needs in participatory design approaches. Hence, both methods supported us in developing scenarios with richer emotional depth and clarity, providing the premise for successful user-centered involvement of non-users.

## Including a Variety of Perspectives

Design processes for older adults are often biased due to recruitment practices and the limited involvement of older adults in certain phases (Mannheim et al., 2022). In this case study, we tried to involve different people who are either experts of their own experience, such as older adults, or industry and geriatric experts. All of their perspectives are relevant to the design process but address a different part of the design. For instance, actual and future practice scenarios focus on the feelings and needs of older

adults. Interaction and detailed interaction scenarios need to cast this knowledge in a mold in the form of a product, in which we require the knowledge of, e.g., engineers and designers. Critically looking at our design process, although we used scenarios as a sensitizing element, we failed to include older adults in phase three. It would have been interesting to let older adults and other stakeholders collaborate on developing a solution. Unfortunately, this was challenging since we had to devise a remote alternative to collaborate digitally (due to COVID-19), and there was a lack of experience to do so effectively. Nonetheless, we feel that using SBD, the different scenarios created a red thread throughout the process that facilitated the transition between phases.

In addition to the inclusion of different perspectives in the process, within phase two, using scenarios allowed us to employ a co-design fiction approach (Ambe et al., 2019). In our design study, we started an open call in a newspaper to collect scenarios written by the readers, who were mostly older adults. Through this, we did not choose a specific group to contribute to a solution, but we invited people to participate who care about late-life loneliness or even experience it themselves. Using this method, we tried to avoid a potential recruiting bias. The 71 submissions of newspaper readers helped us to further identify user needs by using the NADI model (Van der Bijl-Brouwer & Dorst, 2017). We understand that many lonely older adults have difficulties overcoming loneliness as they are suffering an identity crisis, which requires building a new identity through hobbies and lifestyle changes, as well as a support system to fall back to in case of negative experiences. We did not only get a variety of perspectives, but the right perspectives to develop a deep understanding of the solution space.

## Conclusion

Several studies found that scenarios were an effective tool in designing with older adults (Colonius et al., 2010; Demirbilek & Demirkan, 2004; Iacono & Marti, 2014; Robben et al., 2011; Van der Bijl-Brouwer & van der Voort, 2014). Therefore, we chose to use an enriched scenario-based design approach to develop a technological solution aimed at reducing late-life loneliness. The enriched approach offered three benefits that improved the collaboration with older adults, designers, and industry experts: (1) create a level playing field between older adults and experts, (2) evoke empathy through rich scenarios, and (3) include a variety of perspectives.

This paper showcases extensive stakeholder participation and implements various data collection methods to ensure triangulation. It involved 81 older adults and 20 professionals from a range of disciplines (design, computer science, psychology, engineering, sales, social management) that all collaborated to develop a solution addressing late-life loneliness. Additionally, because of Covid-19, we had to translate the process to a remote setting, creating a methodology that can be carried out both physically and online. This made it both cost- and time-efficient.

The overall process resulted in an idea that the stakeholders did not initially expect. Although the effectiveness of the designed solution needs to be evaluated in follow-up studies, we suggest

that the designed solution may help to reduce loneliness in older adults. An additional methodology with a focus on user testing might further strengthen the SBD design process as presented in this study and complete the cycle. This is subject to future research.

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