

# Enhancing creativity in smart home automation

Jochem Verstegen | 1561170 | j.r.p.verstegen@student.tue.nl

## Abstract

This project explored how to stimulate creative ideation in smart home automation through a card-based system. I developed and evaluated a methodology that combines IoT sensors, external data sources, news events, and IoT devices to help users generate innovative automation scenarios. Through a workshop and public demonstration, I found that this approach effectively encourages creative thinking while revealing insights about user preferences in smart home automation. The results suggest that mood-based automations are particularly compelling and that creativity in automation ideas often emerges from unexpected combinations of multiple input sources.

## Introduction

Smart home technology has become an integral part of modern living, creating numerous opportunities for innovative and personalised home automation. As this technology advances, the accessibility of vast external data sources provides an additional dimension for creativity in designing automations. The interconnectedness of devices and data offers a chance to move beyond simple, rule-based actions and explore automations that are creative, satisfying, and engaging.

Despite this potential, many users find it challenging to devise genuinely creative automations which go further than basic input-output rules. In this project, I aim to address this challenge by empowering smart home users to conceptualise inventive automation ideas.

After having explored various problem areas in the smart home domain, such as the difficulty of setting up and maintaining personal cloud storage, or helping non-expert users create DIY smart devices using ESP microcontrollers, I decided to dedicate this project to the difficulty in creating automations that feel satisfying or creative. This challenge stood out as the most feasible and resonated deeply with my personal and professional interests as a designer.

## Limitations in current smart home toolkits

A study by Salovaara et al. [6] investigated smart home toolkits in a family setting and found that many users struggle to develop automations for their homes. The researchers identified four types of automations: utilitarian, motivational, social, and others. However, current toolkits primarily focus on utilitarian automations. The motivational and, particularly, social types of automations can enhance user experience and effectively address real problems faced by users. The existing toolkits, which rely on trigger-action programming, do not sufficiently meet users' needs, especially in social contexts. The authors recommend incorporating reusable templates and providing better guidance to help users create social automations.

Another study by Abbas et al. [1] made use of crowd workers and found that those with intermediate programming experience developed more creative smart home scenarios than those with extensive programming skills. Many of the scenarios created were not realistic or tailored to specific sensors or devices; rather, the more creative scenarios were framed and described specific contexts that could not be easily measured using a particular sensor.

This aligns with the findings of Funk et al. [5], which emphasize the need for a different programming system that can differentiate between activities and scenarios, translate them into states, and further utilise intentions and preferences. Such a system could enable the development of an interactive intentional programming (IIP) system, employing machine learning to generate smart home automations using scenarios as input, with intentions and preferences guiding the actions by the machine learning system.

If users have difficulty brainstorming creative automations when concentrating on specific input and output devices, a system that first helps them define their ideas and then assists in translating those ideas into programmed rules could be beneficial. In this project, I will focus solely on the initial part of this system, setting aside the exact devices needed for automation and instead concentrating on the general concept.

## Visual and tangible programming

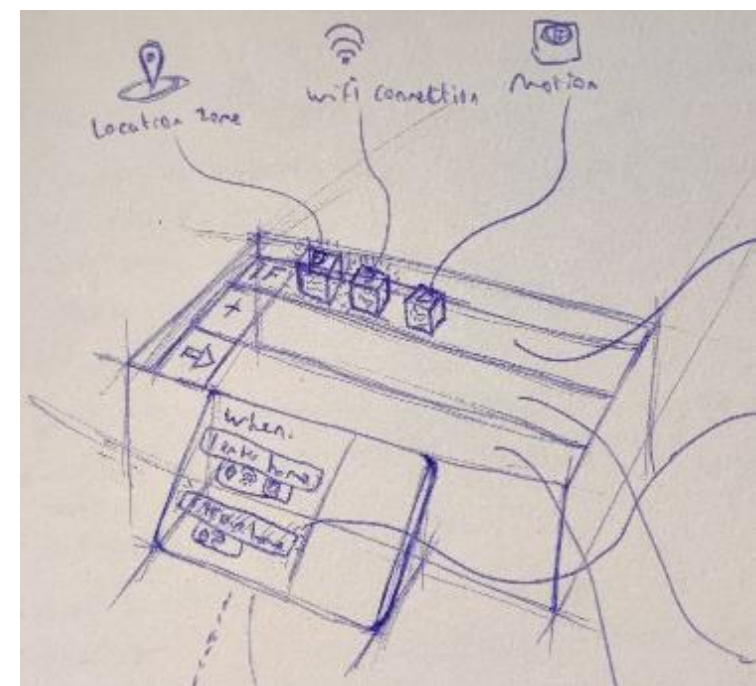
Visual programming systems have made significant strides in regular programming domains, often involving flowcharts or block-based programming to simplify the process for users with minimal programming expertise. One example is Blockly, a block-based visual programming language by Google to create JavaScript programs [8]. There have also been developments regarding visual programming systems in the smart home domain, such as adding IoT-specific blocks and a smart device simulator to Blockly, making it more suitable for smart home automations [12].

Conversely, tangible programming—traditionally applied in educational settings [2, 8, 9]—has seen limited application in the smart home context. One approach uses tangible interaction in the smart home to control devices, such as the SensePods by Khan and Zuolkernan by recognising motions [10]. When it comes to programming automations, some studies have explored the use of tangible programming to physically record events in the smart home [3, 8], the overall potential of this approach in automation remains underutilised. One interesting example is a tangible programming interface by Dudo [4], which uses a wand with RFID technology to link representations of sensors to actuators to build a new automation. By enabling users to interact with physical objects to digitally link smart home devices, tangible programming could offer a more interactive and engaging way to design automations, particularly for those intimidated by traditional programming methods.

## Refining the concept

The initial concept involved creating a "programming sandbox," a collection of miniature IoT devices that users could physically manipulate to design automations. I included representations of complex conditions, such as counters or personalized triggers like recognizing specific individuals. During this phase, I experimented with large language models like ChatGPT, which revealed their potential to support creative processes.

There are multiple possible reasons for people to use smart home technology. One common reason is the potential to enhance comfort, convenience, security and energy use [7, 13, 14]. Another major group of users uses smart home technology as a hobby [13, 15]. The second group is more likely to constantly engage in





tweaking and improving existing automations and looking for new automations to create. Through personal experience, I can recognize myself in both groups. There is a sense of excitement when coming up with a new automation idea, and a sense of satisfaction when it is finished and working.

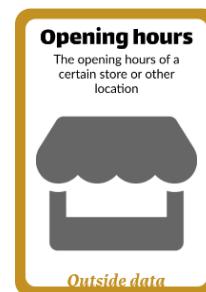
Based on these experiences, I believe that it is important to maintain the engaging feeling of coming up with ideas yourself. The ideas being proposed by generative AI would take away from this engaging feeling and risk diminishing the sense of accomplishment and personal connection to the user's own ideas. Instead, I decided to aim to inspire users to come up with creative ideas for home automation themselves. Recognizing the unknowns surrounding what defines a "creative" automation, I shifted my focus to explore this concept. This called for a more methodological approach to generating creative ideas, both for myself during this project as well as for smart home users.



## Card Set

As a method to spark creativity, I created a card set to explore combining various data types with IoT devices. Since home automation requires inputs and outputs, the card set consists of 45 input cards and 15 output cards, with three different data types for the input cards:

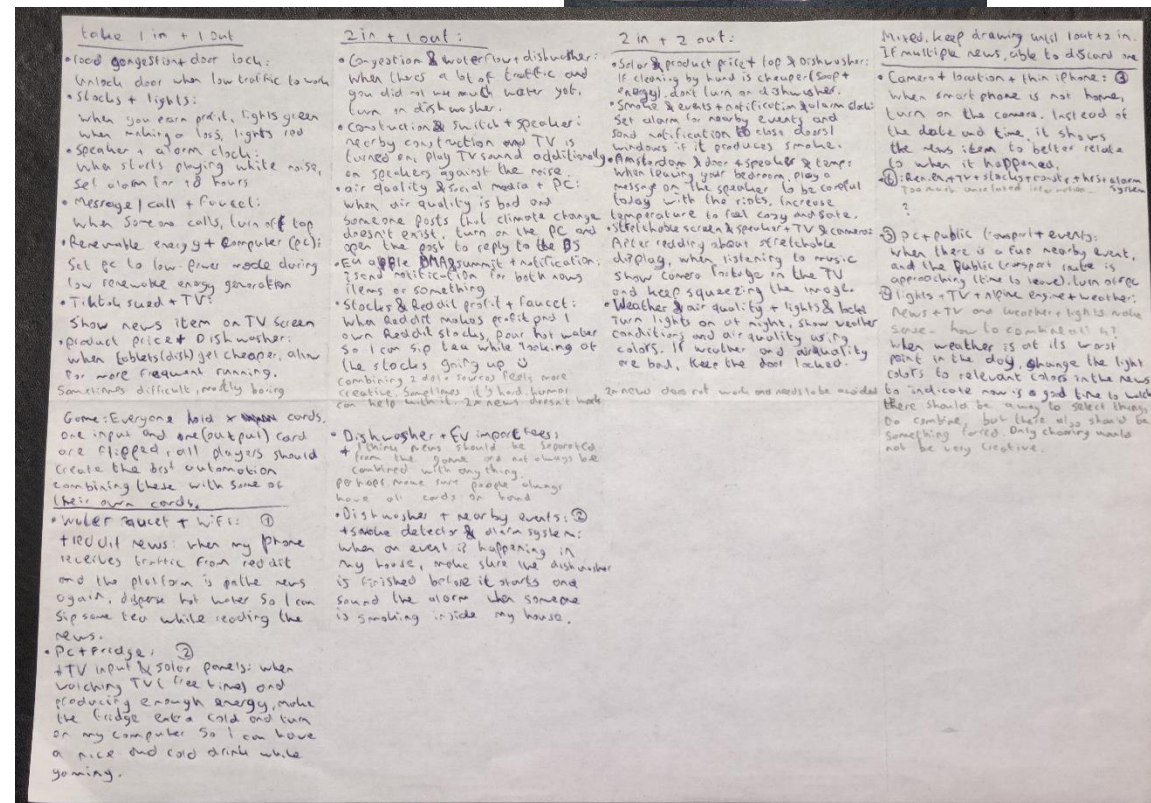
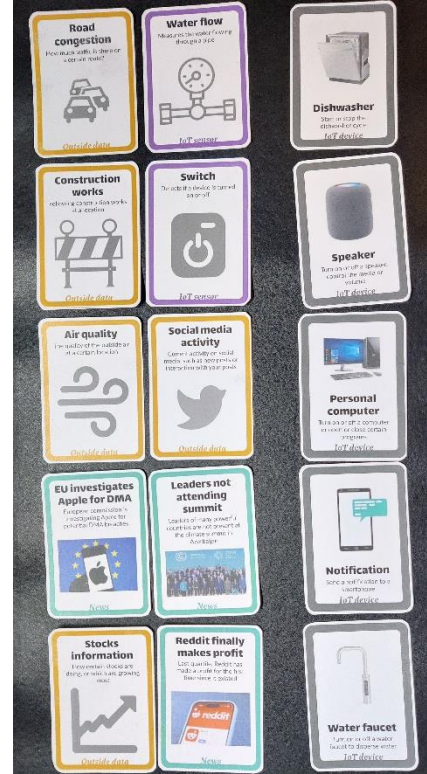
- **IoT Data:** Information from sensors in or around the home (e.g., energy usage, temperature)
- **External Data:** Data from outside sources (e.g., weather, traffic, air quality)
- **News:** Headlines and trends (e.g., election results, major events)
- **IoT Devices (output):** Controllable devices (e.g., lights, speakers, TVs)



There are 15 cards of each type, for a total of 60 cards. After creating the cards, the first step was to try out various card combinations with a varying number of cards and determine the creative potential of the card set, and how it can be used. I attempted to take a certain number of random input and output cards from a shuffled deck, which led me to the following observations:

- Single input-output combinations were often too simplistic to inspire creativity. Only some cases were interesting when the cards did not seem to match at first. An example:
  1. Incoming message/call + Water faucet: *Turn off the faucet when receiving a call*
- Combining two inputs and one output fostered more complex ideas which felt more creative. It was more difficult, but using humour or unexpected connections was helpful. It is usually not possible to combine two “news” cards. Some examples:
  2. Air quality & Social media + PC: *“When air quality is particularly bad and someone posts on social media that climate change does not exist, open the post on my PC so I can reply to the BS and tell them to go outside and breathe some fresh air”*
  3. Stocks & Reddit profit + Water faucet: *“When it is announced that Reddit makes a profit and if I own Reddit stocks at the time, pour hot water from the faucet so I can sip some tea while looking at the stocks (and thus my profit) going up”*
- Two inputs and two outputs felt relatively similar but could be difficult when both output devices are vastly different types of devices. Having multiple outputs did increase the potential for creativity as the output of an automation can be more complex. An example:
  4. Weather & Air quality + Lights & Door lock: *“Turn on some ambient lights to show the weather conditions and air quality using the light colours. If the weather and/or air quality are bad, keep the door locked so I can go outside when it turns better”*
- 4 or more input cards is too much, as it is very likely multiple cards do not align with each other
- In some cases, 2 separate automations seemed logical, making it difficult to combine all cards into one automation

1. News + TV (show news on TV) and Weather + Lights (reflect weather conditions with light colours) were the obvious solutions, which made it take longer to finally come up with one automation: *“When the weather is at its worst point in the day, change the light colours to relevant colours from the news indicating that now is a good time to watch the news on TV”*



Based on my insights from my experimentation with the card set, I determined that it does help me come up with creative automations I would not have come up with on my own. Combining seemingly random data sources and connecting them to random output devices proved to be a good inspiration source for new home automations. While not all automations I came up with are realistic to create (*example 3: Pouring hot water to make tea would require me to always place a cup underneath the faucet*) or practical to use (*example 4: It would be highly inconvenient if the door would remain locked when I need to go outside*), I did find new ideas I would like to attempt implementing into my own smart home (*example 4: Showing the weather conditions using ambient light colours*).

I believe the card set will work even better if there is a balance between forced combinations and the ability to choose. This means that some cards should always be required, while some cards are optional and the user can choose which optional cards to include.

## Workshop and Demoday

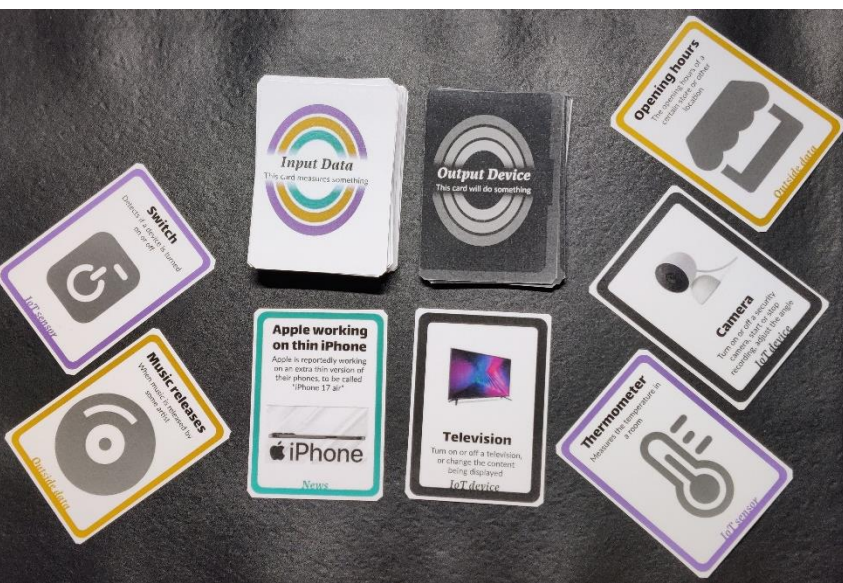
### Workshop

I organized a workshop using these cards to explore several questions:

1. What defines a creative automation?
2. What methods enhance creativity?
3. Can generative AI contribute to creative automations?
4. How do competition and collaboration affect creativity?

In the hour-long workshop, 3 participants engaged in a card game inspired by “Cards Against Humanity”. In the game, each player received 7 cards, 5 input and 2 output cards. Each round consists of the following steps:

1. One player flips over an output card from the deck, the other players need to choose one or more cards from their hand to combine with the card on the table and turn into a creative smart home automation.
2. When ready, both plays play their automation and verbally explain their creative automation.
3. The player who flipped over the output card chooses which automation they think is more creative and explains why.
4. The player who created the winning automation receives a point.
5. The players take as many cards from the deck as they used, so they can start the next round with 5 input and 2 output cards.



The workshop was structured as follows:

1. Welcome the participants and explain the goal of the project.
2. Show and explain the different types of cards and how to use them.
3. Together, make an example automation using one input and one output card to make sure everyone understands what they need to do.
4. Play a few rounds using the aforementioned game rules, for each round one output card is flipped over.
5. Play a few rounds using similar game rules, but now for each round one output card as well as one input card will be flipped over.
6. Using the same rules as before, but now all players collaborate and play against generative AI used by the researcher (the prompt used for this can be found in Appendix A).  
*(only one round due to time limits)*
7. At the end, a group discussion takes place based on the following questions:
  - What makes an automation creative?
  - How did you try to make creative automations?
  - Was it difficult? What helped you achieve it?
  - What was the difference between competing against each other or working with each other?
  - Which cards did you discard and why?
8. Thank all participants for their time, and offer them a small reward of their choosing: A bag of Vietnamese Instant coffee or a Billie coin to use for €1,- discount in the university canteen.

Before the workshop, I conducted a pilot test in which I played a few rounds with one participant and followed the general structure of the workshop. Based on this, I was confident it would be a fun and engaging game when played by at least 3 players. I did not change much about the workshop setup, besides improving the explanation of the card set by first making an example automation together with all participants.

The workshop was approved by the Ethics Committee of TU/e, the ERB form is attached in Appendix B.



## Demoday

During Demoday, an exhibition with numerous projects, I created an exhibition where visitors could interact with my card set and use it to make a creative automation of their own. There were ten placeholders for an automation, consisting of one required input and one required output card, and at least one optional card chosen from 5 input and 2 output cards. I provided sheets of paper to write down the automation and place it underneath the card combination. On this same piece of paper, visitors could indicate whether they think this automation is creative and whether they would want to use it. Any automations created by visitors remained visible for the rest of the day, after which I documented them.



When visitors approached my stand and were interested in my pitch, I actively showed them the cards, handed them some cards and asked them to create an automation. This was necessary because visitors are often hesitant to touch someone's project, despite having clear instructions inviting them to take the cards and use them.

## Results

### Workshop observations

Three participants joined the workshop, all of them are Industrial Design students at TU/e. The participants seemed to enjoy the game and had fun creating various automations and naturally added to each other's ideas. It immediately became clear that a card set can be a powerful source of inspiration when collaborating in a group because the group started collaborating even when no collaboration was required.

Table 1 shows all automations created during the individual rounds, along with the cards used, themes occurring in the automations, and which automation won each round.

Table 1: Automations made during the workshop, which cards were included and the theme of the automation. The winning automation from each round is **bold**

| Rnd. | Required cards                                      | Optional cards                                                   | Automation                                                                                                                                                                              | Theme                    |
|------|-----------------------------------------------------|------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| 1.1  | Power socket                                        | Renewable energy                                                 | <i>Turn on the plug to allow me to use a high-power appliance when there is enough renewable energy</i>                                                                                 | Sustainability           |
|      |                                                     | Actor sued for sexual intimidation + TV                          | <b><i>When there is negative news on the TV I don't want to see, turn off the TV</i></b>                                                                                                | Mood                     |
| 1.2  | Door lock                                           | New self-driving concept car                                     | <i>When there are more self-driving cars outside, lock the door so I stay home</i>                                                                                                      | Safety                   |
|      |                                                     | Light sensor + WiFi + TV + Fridge                                | <b><i>When it is dark outside, and no devices are connected to WiFi (no one is home), turn the TV off, increase the fridge temperature, and lock the door</i></b>                       | Sustainability<br>Safety |
| 1.3  | Camera                                              | Riots in Amsterdam + Air quality + Smoke detector + Notification | <b><i>When there are riots in Amsterdam, monitor the air quality outside and smoke detectors inside, and keep me up-to-date by sending notifications</i></b>                            | Safety<br>Informational  |
|      |                                                     | Blokker bankrupt                                                 | <i>If the cameras see that something has broken, check if I can still buy it at Blokker before they are gone</i>                                                                        | Informational            |
| 1.4  | Water faucet                                        | PC + Calendar + Lights                                           | <b><i>When I finished my online meeting and there is nothing in my calendar anymore, turn off the lamp and give me hot water for a drink</i></b>                                        | Mood                     |
|      |                                                     | Motion sensor + Water flow sensor                                | <i>When there is no motion detected in the kitchen, close the water faucet and check the water flow sensor just in case</i>                                                             | Sustainability           |
| 2.1  | Notification + Leaders not attending climate summit | Alarm clock                                                      | <i>Send a notification about the news. If I get more than 3 notifications about this news item, set a calm alarm indicating I may be missing something important</i>                    | Informational            |
|      |                                                     | Public transit + Alarm system                                    | <b><i>A nearby summit could mess up the public transit, so sound a short alarm to tell me I can leave now</i></b>                                                                       | Informational            |
| 2.2  | Speaker + Switch (sensor)                           | Smoke detector + Air quality                                     | <b><i>If there's a party and there's smoke inside, turn off the music to get everyone outside. If the air quality outside is worse, turn on the music to get people back inside</i></b> | Safety                   |
|      |                                                     | Product price + Social media                                     | <i>When I want to buy something, track the product price and check social media for reviews. Use the speaker to tell me when and where I should buy it</i>                              | Informational            |
| 2.3  | PC + Trump wins elections                           | Stocks + Button                                                  | <i>Show the stock price on my PC, if I press a button, sell the stocks</i>                                                                                                              | Informational            |
|      |                                                     | TV + Dishwasher                                                  | <b><i>Check using the TV whether I have seen the news yet. If not, open the news on my PC and turn on the dishwasher as a nice gesture for me to relax after bad news</i></b>           | Mood                     |

*Table 2: How many times themes occurred and won in the workshop*

| Theme          | Occurring | Winning |
|----------------|-----------|---------|
| Sustainability | 3         | 1       |
| Mood           | 3         | 3       |
| Safety         | 3         | 2       |
| Informational  | 6         | 2       |

The first thing that stands out, is that in all cases, the winning automation used the highest number of cards. There seems to be a direct relationship between the perceived complexity of automations, and the creativity of it.

When grouping the created automations in themes (see Table 2), we can see that 6 automations had to do with providing information to the user, but only 2 of these won. Sustainability, safety and mood were also common themes in automations, each occurring 3 times. All automations aimed at enhancing the user's mood in some way won their round.

Out of the 7 rounds, in 4 cases the participants mentioned the other automation not being useful or desired as the reason for their choice. In the other cases, they chose based on the automation being funny, practical or pleasant. When collaborating to make a more creative automation than generative AI, it was a fairly slow process where the participants considered multiple options before finally deciding on an automation. Even when competing against each other, participants were curious about what the others would come up with. When one player would show their automation, the others would sometimes enthusiastically join in and add to it, sometimes even placing one of their own cards next to it.

During the group discussion afterwards, the participants mentioned that an automation is creative to them based on three aspects: It is personalised, it uses more cards (complex), and it interprets data differently. During the session, participants repeatedly talked about something already existing or not. When asked to clarify, they seemed to agree that they feel an automation would be more creative if it does not exist yet, or if it is applied in a very different context.

To come up with a creative automation, participants would look at the cards on the table and in their hands and think of what they would like to have, which cards seem a little related but not very logical, and try to find a slightly unexpected solution. They mentioned it was difficult at the start, but quickly got easier. Often, the difficulty depended on the cards they got and how much sense they made, news cards were often difficult to use. Throughout the session, only 2 participants discarded one card. In both cases, the reason was that the card was not important to them personally, and they would prefer to have a variety of card categories.

## Demoday insights

In total, seven visitors (3 of whom were a duo) designed an automation at the stand after being prompted by me to do so during the pitch. When I was not present, one more card combination was placed on the table, but no automation was written down for it. Because there was no automation, I did not include it in the analysis. All cards and automations, along with their theme and whether the author thinks it is creative and would want to use it, are shown in Table 3.



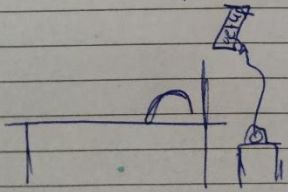
Table 3: Automations created during the demoday exhibition and their cards, themes and ratings

| Required cards                                 | Optional cards                                           | Automation                                                                                                                                                                                   | Theme                          | Rating                      |
|------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|-----------------------------|
| Thin iPhone (news)<br>+ Robot vacuum           | Smoke detector + Road<br>congestion + switch<br>(sensor) | <i>Unknown</i>                                                                                                                                                                               |                                |                             |
| Product price +<br>Water faucet                | Door sensor +<br>Dishwasher                              | <i>If dishwasher pills are cheap, let me use the dishwasher more. If the faucet is still running when I open the door, turn it off</i>                                                       | Cost savings<br>Sustainability | ?                           |
| F1 Alpine engine<br>news + Speaker             | Music releases + Button                                  | <i>If there is news, music related to this news starts to play in the background. When the button is pressed, the news article is read out, when pressed again the speaker stops playing</i> | Informational                  | Would maybe use<br>Creative |
| Stretchable display<br>(news) + Alarm<br>clock | Renewable energy +<br>Speaker (sensor)                   | <i>An alarm clock with a stretchable display which can be kicked to turn it off. When kicked, it plays rhythmic music. It can stretch itself out to stick to the wall</i>                    | Product<br>Waking up           | Would maybe use<br>Creative |
| Thermometer +<br>Door lock                     | Weather + EU<br>investigating Apple +<br>Fridge          | <i>When it is hot outside, the fridge should be locked to stay closed. This only works with Android</i>                                                                                      | Sustainability                 | Would not use<br>Creative   |
| TikTok sued by<br>parents + Lights             | Nearby events + Public<br>transport + Alarm<br>system    | <i>When TikTok contains dangerous content, my alarm system shows a red light. When an event related to TikTok is nearby, I receive a message with transportation options to that event</i>   | Informational                  | Would not use<br>Creative   |
| TV (sensor) +<br>Camera                        | Emergency service +<br>Solar energy                      | <i>Various alarming key words on TV will activate the cameras, alarm system, and solar panels</i>                                                                                            | Safety                         | Would use<br>Creative       |
| Riots in Amsterdam<br>+ Notification           | Power socket + Energy<br>usage                           | <i>The water cooker will turn on when there are riots in Amsterdam, to comfort me with tea</i>                                                                                               | Mood                           | Would use<br>Creative       |

## My Creative Automation

Wake me up before I go

Een wekker met elibaba  
scherm wat je kan stempen  
om hem uit te krijgen. Bij  
de stomp komt ritmische  
muziek. Hij kan zich  
uitreken om te weten je bed  
op de muur te plakken.



|                                           |     |    |
|-------------------------------------------|-----|----|
| Voting: JH                                | Yes | No |
| Would you use this automation at home?    |     | X  |
| Do you think this automation is creative? | X   |    |

One interesting observation is that one duo of visitors, who together created one automation, used the cards to invent a new product rather than a smart home automation (see nr X in Table X). This was unintended, but an interesting observation nonetheless. Perhaps these visitors were not familiar with the concept of home automation, but this does show that a set of cards like this could be used to ideate about new products as well.

All visitors who rated their automation think it is creative. 2 visitors would use their automation (themes: safety and mood) at home, 2 were not sure (themes: informational and waking up) and 2 would not use it (themes: sustainability and informational). One person did not rate their automation.

2 automations consisted of 2 separate automations each, instead of being one connected automation. 4 automations used a card for something unintended, such as using a sensor card as an output device, or to do something the device normally could not do. 2 automations included unused cards, which were not mentioned in the written automation, and 1 performed an action it did not have on a card (sending a notification, which is very common in smart home automations).

## Discussion

In this project, I aimed to find out how to help smart home users come up with creative new automation ideas. To this end, I created a card set with 3 categories of input data and output devices, which was evaluated using a game-like workshop with 3 participants and based on visitor's interactions with it during the Demoday exhibition.

As became evident from the workshop, a higher number of cards is related to more perceived creativity. This is also supported by my own trials, where a small number of cards felt basic, and the interaction with the Demoday stand, where no visitors picked only one additional card. Based on this, I can argue that more complex automations, with more inputs or outputs, feel more creative. Furthermore, participants considered automations to be creative when they are unique, unexpected, fun, or personalised to the user. This could explain why automations regarding the user's mood performed so well. This finding aligns with Salovaara's argument that smart home programming toolkits should better meet the household's social needs [11].

Besides mood, other themes also occurred during the workshop. Automations which provide information to the user occurred the most frequently but were not regularly chosen as a creative automation. Safety and sustainability were other occurring themes. These align with the main reasons for people to use smart home technology in the first place [13, 14].

Automations were not always practical or desirable. Despite being considered creative, participants would not always want to have the automation at home. In 4 out of 7 cases during this workshop, this was the reason for choosing the other automation. Additionally, the results from the Demoday stand showed that creative automations are not always practical, but ideating the automation was still considered enjoyable. Despite this,

the card set can still result in automation ideas which are both creative and practical, but more research could be done to find how to make creative and practical automations people want to use.

All participants of the workshop were curious about the ideas of other players. They would regularly and enthusiastically expand on the ideas of others, even when they were not explicitly asked to do so. This cooperation naturally occurred, indicating that when coming up with automation ideas, it could be beneficial to work together with others. In the round where players had to cooperate to create one automation together, it took significantly longer to come up with an idea because they considered multiple options. Perhaps, this shows that working together from the start is harder than expanding on existing ideas that were made individually.

Overall, it seems like using an element of randomness together with free choice is an effective way to produce new and creative ideas for home automation. The element of combining different data sources with IoT devices is certainly interesting and offers a large potential for users to generate new ideas. This could be explained in part using a phenomenon called “combinational creativity”, which is the act of combining two products or ideas into a new and innovative idea. In 2017, Han et. al defined three driven approaches to combinational creativity: (1) the problem-driven approach, where combinational creativity is driven by design problems, which is the most prevalent; (2) the common-driven approach, where combinational creativity is driven by similarities between ideas; and (3) the inspiration-driven approach, where combinational creativity is driven by a source of inspiration [6]. All three of these approaches can be identified in the automations created using the card set, but more research could be done to explore how combinational creativity can be utilised better in the smart home automation domain.

## Limitations

One important factor for home automation that was left out of this project's scope is the programming. Based on past literature, programming automations in trigger-action programming can be a limiting factor for the creativity of an automation idea. Therefore, I decided against exploring automations able to be programmed. As a result, multiple automations which participants ideated, and in some cases even the ones ideated by me, are not realistically achievable with current smart home systems or current technology. The smart home market could benefit from more research and developments into intuitive tools capable of creating complex and creative automations.

All workshop participants were industrial design students. One common skill for industrial designers is brainstorming and being creative. This likely had an effect on the results from the workshop, which were potentially more creative due to coming from industrial design students. It also could have affected the observation that the participants naturally added to each other's ideas, but the general observation that adding to each other's ideas is more effective than collaboratively brainstorming one idea should remain valid.

## Conclusion

This project demonstrates that methodical tools like the card set can effectively inspire creativity in smart home automation. The combination of randomised required and optional data and devices has a positive effect on the creativity of ideas and can lead to innovative new automations.

## References

- [1] Tahir Abbas, Vassilis-Javed Khan, and Panos Markopoulos. 2020. Investigating the Crowd's Creativity for Creating On-Demand IoT Scenarios. *Int. J. Human-Computer Interact.* 36, 11 (July 2020), 1022–1049. <https://doi.org/10.1080/10447318.2019.1709331>
- [2] Ilene R. Berson and Michael J. Berson. 2010. *High-Tech Tots: Childhood in a Digital World*. IAP.
- [3] Luigi De Russis and Fulvio Corno. 2015. HomeRules: A Tangible End-User Programming Interface for Smart Homes. In *Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA '15)*, April 18, 2015. Association for Computing Machinery, New York, NY, USA, 2109–2114. <https://doi.org/10.1145/2702613.2732795>
- [4] Daniel Dudo. 2018. Designing a tangible programming interface for the internet of things. Technische Universität Wien, Wien. <https://doi.org/10.34726/hss.2018.45568>
- [5] Mathias Funk, Lin Lin Chen, Shao Wen Yang, and Yen Kuang Chen. 2018. Addressing the need to capture scenarios, intentions and preferences: interactive intentional programming in the smart home. *Int. J. Des.* 12, 1 (April 2018), 53–66.
- [6] Ji Han, Dongmyung Park, Feng Shi, Liuqing Chen, Min Hua, and Peter RN Childs. 2019. Three driven approaches to combinational creativity: Problem-, similarity- and inspiration-driven. *Proc. Inst. Mech. Eng. Part C J. Mech. Eng. Sci.* 233, 2 (January 2019), 373–384. <https://doi.org/10.1177/0954406217750189>
- [7] Tom Hargreaves, Charlie Wilson, and Richard Hauxwell-Baldwin. 2018. Learning to live in a smart home. *Build. Res. Inf.* 46, 1 (January 2018), 127–139. <https://doi.org/10.1080/09613218.2017.1286882>
- [8] Michael S. Horn and Robert J. K. Jacob. 2007. Designing tangible programming languages for classroom use. In *Proceedings of the 1st international conference on Tangible and embedded interaction (TEI '07)*, February 15, 2007. Association for Computing Machinery, New York, NY, USA, 159–162. <https://doi.org/10.1145/1226969.1227003>
- [9] Felix Hu, Ariel Zekelman, Michael Horn, and Frances Judd. 2015. Strawbies: explorations in tangible programming. In *Proceedings of the 14th International Conference on Interaction Design and Children (IDC '15)*, June 21, 2015. Association for Computing Machinery, New York, NY, USA, 410–413. <https://doi.org/10.1145/2771839.2771866>
- [10] Waqqas M. Khan and Imran A. Zualkernan. 2018. SensePods: A ZigBee-Based Tangible Smart Home Interface. *IEEE Trans. Consum. Electron.* 64, 2 (May 2018), 145–152. <https://doi.org/10.1109/TCE.2018.2844729>
- [11] Antti Salovaara, Andrea Bellucci, Andrea Vianello, and Giulio Jacucci. 2021. Programmable Smart Home Toolkits Should Better Address Households' Social Needs. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems (CHI '21)*, May 07, 2021. Association for Computing Machinery, New York, NY, USA, 1–14. <https://doi.org/10.1145/3411764.3445770>
- [12] Anthony Savidis, Yannis Valsamakis, and Dimitris Linaritis. 2022. Blockly Toolbox for Visual Programming of Smart IoT Automations. In *Ambient Intelligence – Software and Applications – 12th International Symposium on Ambient Intelligence*, 2022. Springer International Publishing, Cham, 93–103. [https://doi.org/10.1007/978-3-031-06894-2\\_9](https://doi.org/10.1007/978-3-031-06894-2_9)
- [13] Charlie Wilson, Tom Hargreaves, and Richard Hauxwell-Baldwin. 2015. Smart homes and their users: a systematic analysis and key challenges. *Pers. Ubiquitous Comput.* 19, 2 (February 2015), 463–476. <https://doi.org/10.1007/s00779-014-0813-0>
- [14] Ashkan Yaldaie, Jari Porras, and Olaf Drögehorn. 2023. Who are Smart Home Users and What do they Want? – Insights from an International Survey. *Appl. Comput. Syst.* 28, (August 2023), 114–124. <https://doi.org/10.2478/acss-2023-0011>
- [15] Andrew Zaleski. 2018. Meet the Home-Automation Obsessives. *Intelligencer*. Retrieved January 6, 2025 from <https://nymag.com/intelligencer/smarthome/smart-home-obsessives.html>
- [16] Blockly. *Google for Developers*. Retrieved January 5, 2025 from <https://developers.google.com/blockly>

## Appendices

### A. Prompt used for generating creative ideas from cards (ChatGPT)

I need you to create a creative smart home automation using specific input data and output devices. Every time I provide a list of some required and 7 optional cards (these can be input data or output devices), you need to give me a creative smart home automation using the required cards and at least one of the optional ones. Be creative, you can use multiple optional cards in one automation as well.

Provide me with one automation and clearly specify the cards to play.

I will only provide the card category. There are 3 input categories and only one output category:

Input:

- IoT sensor
- Outside data
- News

Output:

- IoT device

Link to ChatGPT conversation: <https://chatgpt.com/share/677eac5c-619c-800b-ab63-34d86acd5276>

### B. Signed ERB Form and confirmation email from ethics committee

Note to reader:

*From the next page, you will find the following documents:*

- *Reflection*
- *Personal Development Plan*
- *FMP Proposal*
- *Previous learning activities overview*

*The signed ERB form and confirmation email are all the way at the end as you likely won't need them.*