Designing a Social Machine for the Heart Manual Service

Citation for published version:

Digital Object Identifier (DOI):
10.5220/0006249004350440

Link:
Link to publication record in Edinburgh Research Explorer

Document Version:
Peer reviewed version

Published In:
Designing a Social Machine for the Heart Manual Service

Vanessa Hanschke, Areti Manataki, Cristina Adriana Alexandru, Petros Papapanagiotou, Carolyn Deighan, Louise Taylor and Dave Robertson

1 Microsoft, Milan, Italy
2 School of Informatics, The University of Edinburgh, Edinburgh, UK
3 The Heart Manual Department, NHS Lothian, Edinburgh, UK
vhanschke@aol.com, {A.Manataki, pe.p}@ed.ac.uk, calexan4@staffmail.ed.ac.uk, {carolyn.deighan, louise.taylor}@nhslothian.scot.nhs.uk, dr@inf.ed.ac.uk

Keywords: social machine, Heart Manual, self-management rehabilitation, participatory design

Abstract: Social machines are emerging as a focus of research within the field of informatics as they begin to become the central administrator of our everyday communications. The difficulty of applying such systems to specialised contexts, such as healthcare, calls for guidelines on how to design them, so that they become truly useful. In collaboration with the Heart Manual Department, this project is an attempt at finding suitable methods for designing social machines in a healthcare context. It suggests that adopting a participatory approach where stakeholders are active, equal participants throughout the design process leads to a more usable, likeable, and thus more successful social machine. We describe the process of designing a social machine for the Heart Manual service, in which requirements were elicited through various participatory design methods and a proof of concept evaluation was carried out with a prototype. The prototype was received largely positively and scored highly on the System Usability Scale, indicating the success of the proposed methodology.

1 INTRODUCTION

The Heart Manual (The Heart Manual Department, 2016) is the UK’s leading home-based supported self-management programme for individuals recovering from acute myocardial infarction and/or revascularisation. With the help of a team of facilitators (typically nurses, psychologists or general practitioners), who are based in different locations nationally and internationally, it guides patients through a series of sessions which empower them to improve their lifestyle. Apart from the initial training that facilitators receive, there is no infrastructure for community building, and knowledge exchange takes place in an ad-hoc fashion, with individual facilitators contacting the Heart Manual (HM) team to clarify their questions.

Social machines (Hendler and Berners-Lee, 2010) can provide an appropriate infrastructure for such interactions. Through a closer interaction between humans and machines, such systems can support communication and the sharing of experience, and contribute to a sense of community. Despite recent research interest in this topic, there are still no best practices for designing successful social machines.

In this paper, we propose a participatory approach to the design of healthcare social machines. We posit that the involvement of users throughout the design process can address usability and likeability aspects, which are key success factors for health technologies. In particular, we describe our experience in employing participatory design methods to develop a social machine for the HM facilitators. Background information is provided in Section 2 and our methodology is introduced in Section 3, followed by an account of requirement elicitation in Section 4. We next present a first prototype created to collect quick feedback (Section 5) and how this was further adapted and evaluated by HM facilitators (Section 6). We conclude with an overview of lessons learnt and future work.

2 BACKGROUND

The Heart Manual (The Heart Manual Department, 2016) is a home based cardiac rehabilitation programme, supported by trained facilitators and evidenced by three randomized control trials (Clark et al., 2011). It consists of six weekly sessions that include education, exercise, relaxation and stress management. The programme was digitised in 2015
Social machines are technology-enabled social systems, seen as computational entities governed by both computational and social processes (Hendler and Berners-Lee, 2010). They are defined as “Web-based socio-technical systems in which the human and technological elements play the role of participant machinery with respect to the mechanistic realization of system-level processes” (Smart et al., 2014). Social machines are a recent research theme, with related work focusing mostly on analysing existing examples, such as Facebook, Wikipedia and Stack Overflow (Shadbolt et al., 2013; Smart et al., 2014). Literature on designing social machines is relatively sparse. Donath (Donath, 2014) approaches this topic in terms of conceptualising communities and strengthening ties, while Murray-Rust and Robertson (Murray-Rust and Robertson, 2015) suggest using existing social machines that bring together designers and developers to generate new social machines. Both approaches push for an understanding of the users and a close tailoring of the social machine to its participants. Yet we are still lacking guidelines for practical requirement elicitation for new social machines.

In healthcare, a number of social machines aim to bring patients together to help them live healthier lives. PatientsLikeMe.com, for instance, connects patients with similar conditions, allowing for peer support and knowledge sharing, while the Fitbit and Nike+ FuelBand online communities operate as behavioural interventions that complement activity trackers. However, the majority of such machines lack a clinical evaluation, and there are concerns around confidentiality and patient self-diagnosis.

Similarly to the proposed HM social machine, other machines connect clinicians rather than patients (e.g. doc2doc.bmj.com). A recent review (Rolls et al., 2016) explores how social media have helped health professionals worldwide create virtual communities where they exchange knowledge and network. However, the paper does not give a comprehensive review of design methodologies. The closest example in this literature were the trials for the Midwifery Forum (Brooks et al., 2004). However, the participatory design mentioned in the paper was limited to prototype evaluation, rather than collaborative design.

3 METHODOLOGY

The lack of guidelines for designing social machines is a considerable gap, especially in the healthcare context, where technology uptake is relatively slow. Including the capabilities of the users in the interface design can have a significant effect on its usability and, thus, the success of a healthcare social machine.

We thus adopt a participatory approach to the design of a social machine for the HM facilitators. Participatory design is a user-centred design methodology, in which the end-user is made a full participant of the design process, typically by interacting with mock-ups, prototypes and other tools that represent developing systems (Schuler and Namioka, 1993; Simonsen and Robertson, 2012). We hypothesise that participatory design is an effective method for the design of a social machine of health services with respect to system likeability and usability, as measured by a small-scale evaluation of a web-based prototype.

An iterative development process was followed, consisting of three main phases: requirements elicitation, low-tech paper-based prototype design and high-tech wireframe prototype development. Inspired by the spiral model of software development, each phase included a repetition of steps, namely planning objectives, collecting information from users, analysing their feedback and creating a next level prototype (or list of requirements, in the case of Phase 1).

4 ESTABLISHING REQUIREMENTS

We utilised Shadbolt’s constructs for classifying social machines (Shadbolt et al., 2013; Smart et al., 2014) to establish a set of questions which provide a framework for gathering requirements for a social machine. The questions devised cover the tasks and purpose of participation, participants and their roles, as well as motivation and incentives (see Figure 1).

Three main methods were used for establishing requirements, described hereafter.

Training session: We first attended a two-day training session that prepares healthcare professionals to become facilitators of the HM programme. This allowed us to gain a clearer understanding of their role and the challenges they face (e.g. cultural issues that might impede patients from following dietary restrictions). To address such challenges, the session also made apparent the usefulness of a space for facilitators to discuss their opinions and experiences, share good practice and provide peer support, especially in the case of facilitators working in remote areas.

Brainstorming session: This was organised in the form of a “Future Workshop” towards idea generation (Simonsen and Robertson, 2012). Future workshops are common in participatory design and consist
of three stages: i) critiquing the present, ii) envisioning the future and iii) implementing - moving from present to the future. Four clinicians participated in the workshop: a health psychologist, an assistant psychologist, a specialist nurse who is also an HM facilitator, and the lead of the HM team. Following the Future Workshop structure, we first focused on existing communication between clinicians, and then we discussed the goals of the HM social machine. Based on these goals, the participants were then asked to devise dream solutions, unrestricted by technical knowledge or possibilities. Three examples of social machines were then presented to them: Facebook, doc2doc and Stack Overflow. These were carefully chosen, so as to prompt discussions around different forms of communication, privacy and confidentiality regulations, as well as user reputation, respectively. This presentation initiated a new discussion about the dream solutions, leading to a jointly ordered list of requirements.

**Telephone interviews:** Three semi-structured interviews with additional facilitators were organised so as to verify some of the ideas collected previously, as well as to clarify points where participants had differing opinions. For example, participants gave their opinion about the motivation for a social machine and the associated concerns, the need for private groups or private messaging, anonymous posting, etc.

The brainstorming session and telephone interviews were recorded (with the written consent of the participants), transcribed and analysed following top-down thematic analysis, as guided by the questions in Figure 1. Outputs included explicit answers to these questions (presented in the same figure), leading to a list of functional and non-functional requirements. Among functional requirements, we distinguish the following elements: discussion forum, quizzes, surveys, blogs, events and notepad. Posting anonymously and tagging content as helpful were deemed desirable, but setting up groups or private messaging were not. The list of non-functional requirements included high levels of security and privacy, low maintainability and the option to report forum abuse.

5 FIRST PROTOTYPE AND ITS EVALUATION

Following best practices in participatory design (Simonsen and Robertson, 2012) and based on the requirements gathered, we created a low-fidelity, paper-based website prototype, so as to quickly obtain feedback and generate ideas at an early stage of the design process, before committing to design decisions that would be harder to change later on. A set of pages were designed to capture the main functionality of the website: i) homepage, ii) discussions, iii) submitting a discussion (see Figure 2) and iv) user profile.

A prototyping session was organised to collect feedback, with the partaking of the four participants from the brainstorming session. Each participant was questioned individually around two activities. In the first activity, they were given a set of cut out items
Figure 2: Paper-based prototype for submitting a discussion (e.g. buttons and taskbars) which they could arrange on a sheet of paper to reflect their idea of the homepage. In the second activity, they were presented suggestions for the design of the screens to elicit opinions and given screen print-outs to annotate. Topics discussed included the notes facility and the presentation of ground rules for participating in the discussions, so as to avoid misinformation and breach of confidentiality. The prototyping session was audio-recorded, handwritten notes were taken and any visual material created was documented with photographs. These resources were analysed qualitatively using a combination of top-down and bottom-up thematic analysis. In general, it was found that participants were pleased with the layout that was presented to them. Opinions were evenly split on the presentation of the ground rules and on a simple versus busy look of the homepage. A pop-up window and a busy feel, respectively, were chosen by the designer for the next version of the prototype, which would be further evaluated, thus reducing the associated risk.

6 FINAL PROTOTYPE AND ITS EVALUATION

A hi-fi web-based prototype was developed by adapting the first prototype given the feedback gathered. It was presented on a browser and made from linked screens to generate a feel of the interactions that would take place (see Figure 3). Its main difference to the first prototype was that users could interact with the system and see its dynamics in operation. The prototype was not fully functional, but a proof of concept. It was designed to work for certain scenarios that were set up for the evaluation: 1) starting a discussion, 2) entering a discussion point, 3) marking a contribution as helpful, 4) reporting a contribution as harmful, 5) entering an event, 6) adding items to favourites, and 7) accessing favourites.

The prototype was tested with seven potential users (five members of the HM team and two facilitators) for usability and likeability. Three of the HM team members had participated in the first prototyping session, while the remaining two had not been involved in any of the prior activities. The two additional facilitators had been interviewed for establishing requirements. The evaluation was divided in two main activities (i.e. think aloud and questionnaire), while a survey was set up for carrying it out remotely.

**Think Aloud and Short Structured Interviews:** For this part of the evaluation, participants were presented with the prototype on a laptop. They were given four sets of tasks: 1) submit a new discussion, 2) find a discussion, mark it as a favourite, mark and report a contribution, 3) find an event and mark it as a favourite and 4) revisit favourites. The participants were asked to "think aloud" while completing these tasks, i.e. explain their thought process, so as to make explicit where they were stuck and why, what they were looking for, what their expectations were, etc. Following their think aloud, participants gave their opinion about the presented features and their intuitiveness.

**Questionnaire:** Participants were next presented...
with a questionnaire around usability and likeabili-
y, which included three sets of questions: i) SUS
scale (Brooke, 2013), ii) how often (in a scale from 1,
i.e. never, to 5, i.e. very often) participants thought
they would use certain features and iii) whether they
thought certain aspects were particularly enjoyable,
enjoyable or concerning and why.
Survey: Participants who performed the evaluation
remotely were emailed an online survey containing
the same questionnaire and Think Aloud tasks, and
a link to the prototype. They were also asked to put
remarks in comments if they were stuck at any point,
especially if they were unable to complete the task.

The five participants of the HM team carried out
the different evaluation activities in the presence of
the researcher. One of the facilitators completed the
evaluation using the survey, while the other completed
it remotely, with the researcher on the phone and
watching the screen navigation in real time.

The Think Aloud sessions and structured inter-
views were audio recorded (with the participants’ per-
mission), transcribed and, together with the survey
data, analysed qualitatively using a combination of
top-down and bottom-up thematic analysis. Inter-
view or on-line survey replies on intuitiveness were
attributed a ranking from 1 to 5. During the Think
Aloud session, the time for completing each task
was recorded, and notes were taken about whether it
was completed successfully and the number of errors.
These data were analysed quantitatively with regards
to efficiency, task accuracy and completeness. Ques-
tionnaires were also analysed quantitatively.

Figure 4 presents the accuracy and completeness
measured during the Think Aloud session. All partic-
ipants were able to complete all tasks independently,
except for one participant who required further expla-
nations on two tasks. The errors observed had to do
with misunderstanding instructions and with the fact
that the search bar lacked functionality at this stage.

Regarding efficiency, the average time in seconds
for each of Tasks 1-4 was: 57.4 (SD 57.4), 67.4 (SD
43.5), 21 (SD 8) and 35 (SD 19.4), respectively. Note
that the standard deviations here are inevitably large,
given the small number of participants recruited.

Based on participant remarks and answers during
the Think Aloud session and the short structured in-
terviews, all tasks scored highly on intuitiveness: the
average intuitiveness score (on a scale from 1 to 5) for
Tasks 1-4 was 4.6, 4.4, 5 and 3.7, respectively.

The average SUS score was 86.4 (SD 18.02), indi-
cating “excellent” satisfaction, according to published
grade rankings of SUS scores (Bangor et al., 2009).
With the exception of one participant who gave a
score of 50 (i.e. “ok”), the rest of the scores ranged
from 80 (i.e. “Good”) to 100 (i.e.“Best imaginable”).

The results to the question of how often partici-
pants would use certain features ranged from 3 (i.e.
every now and then) to 4.43 (i.e. between regularly
and very often). The former was assigned to the use
of the notepad for keeping personal notes, while the
latter to reading discussions and looking up events.

A variety of features were found to be enjoyable.
Discussions, in particular, were mentioned by five out
of the seven participants. For instance, a facilitator
mentioned: “Starting a discussion. I liked that. And
I liked it because if I know I’ve got a thought in my
head and I can put it out there and see what my col-
leagues and counterparts have. So it can validate the
ideas I might have”. Three facilitators mentioned that
the favourites feature also seemed very useful. No
feature was pointed out as unenjoyable or concerning.

7 CONCLUSIONS

Based on the quantitative measures presented in Sec-
tion 6, the hi-fi prototype was a great success, per-
forming well on both satisfaction and effectiveness.
The SUS score was very positive, corresponding to an
“excellent” usability grade. Only one user was un-
able to complete two tasks independently, totalling an
overall average of 92% success per user. The overall
error rate was low, with no errors on many tasks and
less than one error on average for tasks with errors.
Some of the errors, such as accessing the search bar
(which was not yet functional), are easily resolvable.
The efficiency of the tasks can only be compared be-
tween each other, as we do not have an absolute mea-
sure of how long these should take. A learning effect
between Tasks 1 and 3 can be noted, as they take a
similar amount of clicks, but the latter is faster.

The system seemed to have a high level of accep-
tance, as most features were marked to be used be-
tween “every now and then” and “very often”. This
shows that the features proposed in the prototype were
in line with the expectations of the participants. This
is also demonstrated by the fact that discussions were
highlighted as a particularly enjoyable feature.

This interdisciplinary project highlighted several
themes which we expect to be recurring when design-
ing social machines for health professionals, given the
general characteristics of the domain. Firstly, design-
ing for time constraints is crucial, given that clini-
cians are very busy. Hence, an easily learnable inter-
face is recommended, where all features are directly
accessible on display. Security is another important
theme, and access control aspects should be carefully
thought out. Furthermore, social machines that sup-
port knowledge sharing should allow users to identify
misinformation, which is critical in healthcare.

The choice of participatory design allowed us to
identify these themes and concerns, which might not
have been addressed without input from the users.
Our overall experience of using participatory design
in healthcare was greatly positive. Participants were
very motivated and gave thorough and careful feed-
back. On the other hand, recruiting participants was
the biggest issue, as healthcare professionals are gen-
erally very busy and communication channels tend to
be controlled. We worked around this issue by ensur-
ing that different types of stakeholders were involved
in the study, from experienced to new facilitators and
from isolated workplaces to busy hospitals.

The range of participatory design methods used
provided us with a wealth of both quantitative and
qualitative data and allowed for a good level of user
engagement and interaction. The two-hour brain-
storming session, which resulted in 26 pages of tran-
script, allowed participants to exchange and visualise
ideas, and thus served as a good basis for establish-
ing requirements. The phone interviews did not pro-
vide the same level of idea generation, but carrying
them out separately with each facilitator provided a
safe space for them to express their personal views on
a HM machine. Furthermore, the paper-based proto-
otyping session was found to be very useful, as it al-
lowed us to concretise ideas at an early stage.

The questions presented in Figure 1 were partic-
ularly useful for designing the HM social machine.
They guided the requirement elicitation process, from
structuring the brainstorming session to analysing the
qualitative data obtained. We would, hence, recom-
mand their use to other social machine designers.

In the future, we wish to continue using the partic-
ipatory design methodology and implement the feedback
received as part of the current study. In order
to create a truly usable social machine for the Heart
Manual service, we plan to include more participants
and to investigate new topics, such as the moderat-
ing role of the HM team. Applying the methodology
presented in this paper to the design of other social
machines is another exciting avenue for future work.

ACKNOWLEDGEMENTS

This research was supported by the EPSRC SociaM
project under grant EP/J017728/1.

REFERENCES

what individual SUS scores mean: Adding an adjecti-
on the net: new communication technology. British
Clark, M., Kelly, T., and Deighan, C. (2011). A system-
atic review of the heart manual literature. European
Deighan, C., Pagliari, C., Michalova, L., Elliott, J., Brook-
making technology accessible with a user-friendly re-
source. In Health Informatics Scotland Conference.
British Computer Society.
Donath, J. (2014). The social machine: designs for living
online. MIT Press.
Hendler, J. and Berners-Lee, T. (2010). From the seman-
tic web to social machines: A research challenge for
AI on the world wide web. Artificial Intelligence,
the next generation of social machines. In Crowd-
sourcing, pages 53–71. Springer.
How health care professionals use social media to cre-
ate virtual communities: An integrative review. Jour-
nal of Medical Internet Research, 18(6):e166.
Schuler, D. and Namioka, A., editors (1993). Participatory
Design: Principles and Practices. L. Erlbaum Asso-
ciates Inc., Hillsdale, NJ, USA.
Shadbolt, N. R., Smith, D. A., Simperl, E., Van Kleek, M.,
framework for social machines. In Proceedings of the
22nd International Conference on World Wide Web,
pages 905–912. ACM.
Simonsen, J. and Robertson, T. (2012). Routledge Interna-
tional Handbook of Participatory Design. Routledge.
Smart, P., Simperl, E., and Shadbolt, N. (2014). A taxo-
nomic framework for social machines. In Social Col-
lective Intelligence, pages 51–85. Springer.