Applying a User-Centered, Rapid-Prototyping Methodology with Quantified Self: a case study with triathletes

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***Abstract*—This workshop paper discusses how we applied a user-centered, rapid-prototyping methodology to design and evaluate a Quantified Self dashboard for triathletes. Quantified Self barriers as discussed by Li and Forlizzi [1] and Choe et al. [2] are taken into account. A dashboard is designed for and evaluated with in total 25 triathletes and fourteen regular persons. Our results confirm that this methodology is successful and a well designed dashboard can be used to help users analyze their own data.**

I. Introduction and Background

The importance of Quantified Self or Personal Informatics [1] for (Personal) Healthcare is undeniable. Yet several barriers hinder the broad use of Quantified Self.

Li and Forlizzi [1] list the following barriers:

B1) lack of time,
B2) insufficient motivation,
B3) unsuitable visualization and poor analytics tools,
B4) poor skills for analyzing data,
B5) fragmented and scattered data.

Choe et al. [2] list other, complementary barriers:

B6) tracking too many things,
B7) insufficient scientific rigor.

The most important problem is to gain insights from Quantified Self data, as confirmed in [3] and [4]. Yet Quantified Self can promote positive behavior change [5], which benefits healthcare [2]. Users can learn to act prospective to their health conditions instead of retrospective [6].

This paper discusses how we addressed these barriers in our design of a Quantified Self dashboard for triathletes, called TriaTriumph[1], using a user-centered, rapid-prototyping methodology. Triathlon is characterized by races that consist of the sequential completion of three endurance sport disciplines, namely swimming, cycling and running. Races can come in different formats, ranging from the Ironman distance (3.8 km swimming, 180.2 km cycling and 42.2 km running) to the sprint distance (0.75 km swimming, 20 km cycling and 5 km running). Most triathletes practice triathlon in a recreational way, without intervention of a personal coach. However, having a personal coach has the advantage of having the knowledge on how to practice in order to be in best shape at a certain point in time (e.g. a race). Unfortunately, because of the financial costs of personal coaches, most triathletes do not have this specific knowledge. Quantified Self techniques do not necessarily have to be expensive (e.g. pen and paper, excel, cheap fitness trackers, etc.) and can be used by more triathletes. Providing the triathletes with good visualization tools of their personal data consequently helps them to gain knowledge and reflect on their health status to prepare for a race.

The only alternative dashboard for triathletes that we are aware of is TrainingPeaks[2]. It is a web-based application that also focuses on triathlon and offers a wide range of functionality: the possibility to plan workouts, add the results of each workout, set goals, keep up with daily food intake, join training, feeding plans, etc. Thus not taking into account that tracking too many things could be a disadvantage [2] (**B6**). Furthermore, the results are visualized with non-optimal visualizations (e.g. pie charts [7]), which makes it harder for triathletes to analyze their data (**B3**).

We primarily designed our dashboard to show that a user-centered, rapid-prototyping methodology helps to take the Quantified Self barriers into account when designing and evaluating a Quantified Self dashboard and secondarily to bring added value to the sports industry in terms of dashboard design.

II. Methodology

In our study we use a user-centered, rapid-prototyping methodology. We first conducted a survey to discover the target audience and to add scientific rigor. Afterwards, an iterative design process is used to reach the final design of the dashboard. In each iteration, a prototype is developed that tries to solve the problems that came up in the previous prototype. The first two prototypes are designed on paper to define the foundations of the dashboard. The advantage of a paper prototype is that the prototype can easily be redrawn, without loosing time in the technical

[1] http://www.triatriumph.com

[2] http://trainingpeaks.com/

implementation of changes. When a paper prototype has more or less no big issues, time is spent in digitalizing the prototype.

Throughout the individual evaluations, commonly used evaluation techniques are applied. The *think aloud method* [8] is used to let people explain what they perceive by seeing a part of the dashboard. In this way, it can be tested whether the users do get the message that the dashboard tries to express. If not, there is probably a problem in its design. Another approach of think aloud is to give the users a task that has to be completed by interacting with the dashboard. Users have to explain which steps they should undertake to fulfill the task. This approach gives insights on the usability of the design, more concrete whether tasks are fulfilled in a way that they are intended to. At the end of each evaluation, some specific questions are asked about the content of the dashboard. Finally, the usability is quantified using a System Usability Scale (SUS) questionnaire [9].

The final dashboard, is subjected to a final evaluation. This evaluation consists of two parts: 1) a trial period where triathletes use the dashboard for two weeks and 2) using Google Analytics[3] to track which actions the triathletes are performing with the dashboard.

III. Study

Our study is divided into three major parts. First a survey to gain initial insights, thereafter the dashboard is designed through a rapid prototyping process and finally the dashboard is evaluated for usability and usefulness.

A. Survey

To add scientific rigor (**B7**) and to familiarize with our target audience, an initial survey is performed with 66 triathletes. The survey primarily served to learn if and what kind of personal information is already tracked, which tools are used, if a smartphone is used during training and if a predefined training plan is followed. Weight (42%), morning heart rate (17%), sleep quality (5%) and body feeling (5%) are the most recorded personal information data. 32% uses a spreadsheet program to store these data, which indicates that triathletes do not know the existence of specific triathlon applications or there are currently no suitable applications available. Only 24% of the participants carry a smartphone while practicing. Yet sport watches (52%) seem to be popular. 65% of the participants use a predefined training plan for the upcoming week. This means that most triathletes already plan at the beginning of a week which training plan they will follow during that week.

B. Rapid Prototyping

The information that is gained from the survey is used as a basis for the information that is displayed in the design. By listening to the needs of the triathletes, a useful tool (**B3**) can be built that combines the fragmented data (**B5**). We chose to develop a tool that visualizes the physical fitness over time using visualizations (**B4**). The application does not have to be mobile, since smartphones scored low in the survey. The advantage is that the visualizations can by displayed on a bigger screen. We thus chose to design a web-based dashboard. According to good dashboard design [10], the user should not have to scroll through the dashboard to perceive all the information. When related information cannot be captured in a single view, there is the risk that some relationships between numbers are not noticed. However, providing insights is the goal of the dashboard. Putting a lot of information on one screen can lead to a crowded and overwhelming impression. This is a major challenge in designing dashboards [11] and relates to the Quantified Self barriers of ‘unsuitable visualization and poor analytics tools’ (**B3**) and ‘tracking too many things’ (**B6**). This challenge is therefore evaluated and tackled through the different prototypes. Four different prototypes are designed. A complete description of the rapid prototyping process can be found in [12]. This section only entails the important details for this research.

1) Initial design: The design of the first paper prototype is made up of levels and is shown in Figure 1. This prototype does not satisfy the property of fitting completely on one screen without scrolling. A lot of information is displayed because it was not clear which information is considered as most important by triathletes. Therefore, the major goal of the rapid prototyping process is to define the most important concepts of the dashboard. Participants are asked to give the four most important boxes of the dashboard. The prototype is evaluated for one hour with nine sports people, including seven triathletes. Seven participants (78%) indicated that the design had a very crowded impression, as was expected. All participants agreed that ‘my planning & progress’ is the most important information. Six of the seven triathletes did not like the content of the ‘my physical fitness’ box. A preparation for a race consists of intensive weeks and weeks of rest. Using the average velocity will give the impression that the physical fitness is getting worse in a week of rest, while this is not true. Three of these six triathletes suggested another approach to estimate the increase in physical fitness. For each discipline, a contest is done around every two weeks, where triathletes try to accomplish a distance as fast as possible. It is useful to plot these timings on a graph. This interpretation is used and evaluated in the next prototype. Despite the crowded impression, the design received a SUS score of 83.6.

2) Subsequent prototypes: The second prototype addressed most issues that occurred in the first prototype: too much information, possibility to add training results directly, the introduction of training activities and a filter to chose the users that are included in the calculation of the average training intensity values. Triathletes can now compare their values against users with the same sex, the same age category and the same skill. The second prototype is evaluated for 45 minutes with eight triathletes. Only one triathlete (12.5%) indicated that the design had a too crowded impression. This is much better than the 78% from the previous prototype. This gives an indication that the design is going in the right direction. The SUS score also increased to 86.3.

[3]http://www.google.com/analytics/

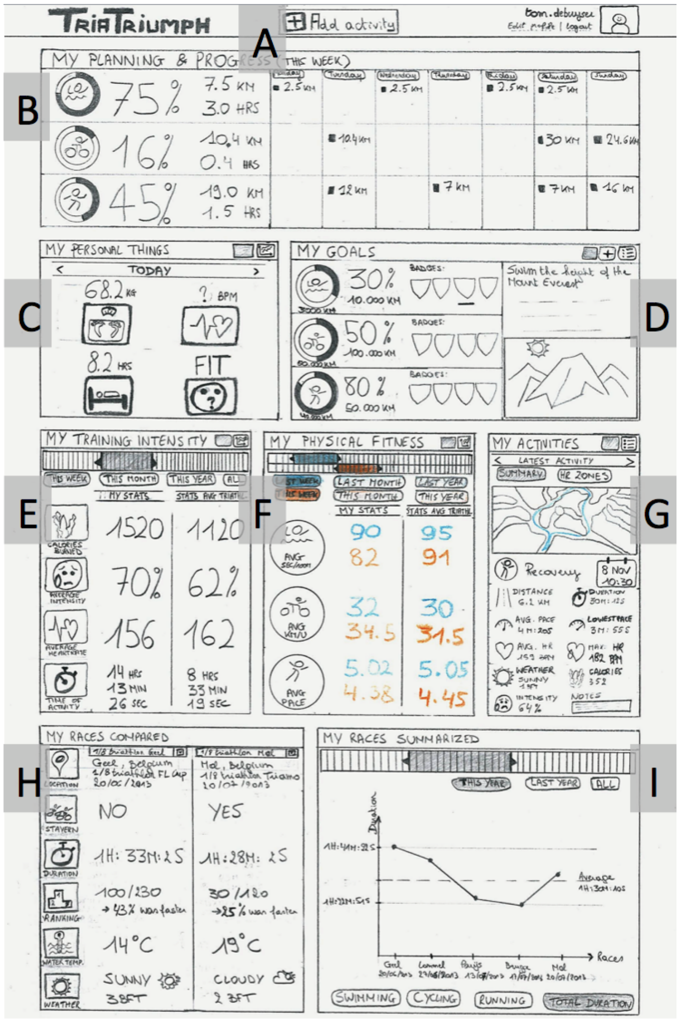

Fig. 1. The initial design. (A) possibility to add activities, (B) a planning module divided into the three disciplines, (C) personal data: weight, morning heart rate, hours of sleep and body feeling, (D) goals and badges to motivate the triathletes to remain collecting personal data, (E) training intensity and possibility to compare with other triathletes, (F) a possibility to show whether the physical fitness of the athlete is getting better, (G) summary of an individual activity, (H) a module to compare races with your peers and (I) a summary of all performed races.

There are not many issues with the second prototype and the third prototype is therefore nearly identical to the second prototype, but digitalized. To eliminate usability issues in the final evaluation, this prototype is evaluated with twelve participants with a more technical background. Questions about the content are thus not asked, as none of them are triathletes. The remarks involved mostly technical issues (e.g. the functionality of the time sliders was not clearly indicated) that are resolved in the final design. The SUS score of 84.6 is a little lower in comparison with the SUS score of the triathletes due to the first question which measures the usefulness specifically.

3) Final design: The final version[4] of the dashboard is shown in Figure 2 and implemented according to a REST architecture. It therefore consists of three layers: a UI layer, a REST API layer and a Database layer. The UI layer is implemented with a combination of HTLM5, CSS3, JavaScript and jQuery. The REST API layer is implemented in node.js. Mongoose is used to communicate with the database and Passport to handle user management. We also used Express, which is a framework on top of node.js to create an initial structure for the node application. The Database layer consists of a MongoDB that gets accessed by Mongoose. This implies that the dashboard is fully interactive with real life data. Adding the result of a physical contest will trigger a change in other elements of the dashboard: the progress in the planning is updated, the training intensity will be recalculated and the contest will be added to the graph of physical contests. The graphs for both personal specifications and training intensity show the evolution of the four values on top of each other, so that a comparison on a daily basis is possible. In this way, the values can be related to each other more easily. The graph of physical contests shows all the times of contests that are done in the selected time period. A trend line and average line are added to more quickly observe the global trend. Clicking on a data point will show the details of the contest in the right upper corner of the dashboard.

[4]http://www.triatriumph.com

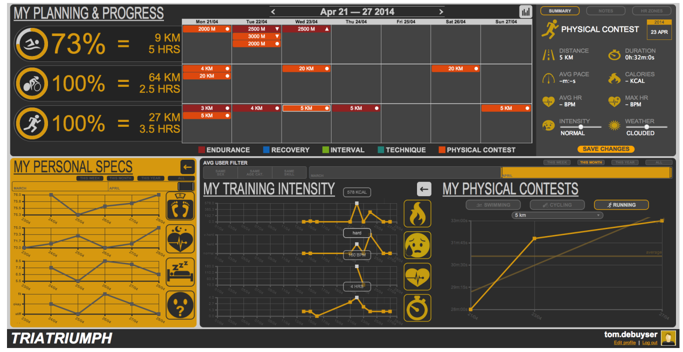

Fig. 2. Final version of the dashboard where the graphs are shown

C. Evaluation

The final version of the dashboard is subjected to a final evaluation in order to examine the added value of the dashboard and to check if the Quantified Self barriers are accounted for. Ten triathletes are asked to use the dashboard intensively for two weeks. Before this trial period, they are first presented a questionnaire with sixteen assignments. The participants had to indicate which applications they used so far and rate the perceived difficulty to perform certain tasks. During the trial period all their actions with the dashboard are tracked using Google Analytics. After the trial period the participants are asked to fill in the same questionnaire based on the data stored and presented in the dashboard to compare the perceived usefulness of our dashboard with the existing tools. Finally a SUS questionnaire ended the trial period.

IV. Results and discussion

According to the initial questionnaire, the participants could be divided in three groups: four participants use software of sports watches, four triathletes use Excel spreadsheets and two triathletes use smartphone applications. We found that for each assignment, as well the ease as the time needed to perform the assignment improved by using the dashboard in the second questionnaire. On average, the dashboard showed an improvement for each participant, except one, for both ease and needed time. Using the dashboard showed a very little decline in ease for one of the persons of the sports watches group. Afterwards, we asked that person to give some more feedback on his results. He said that he did not like the manual logging, whereby he only filled in the duration and distance of each training. Thereby, only a little percentage of the functionality is used, so not all assignments could be solved because of a lack of information. This is similar to the second barrier (**B2**) and can be addressed in future work with automatic logging using wearables. The SUS questionnaire somewhat proved this cumbersome approach of manual logging. As it is tested in the eighth question ("I found the system very cumbersome to use") of the SUS questionnaire. This question had an average of 3 out of 5, where 5 means very cumbersome. The final average SUS score dropped to 78.8.

The Google Analytics data showed that the website had a total of 91 unique users in the same period of the trial period. From these 91 users, 13 active accounts are created. The average duration on the website is 5 minutes and 55 seconds, for the dashboard it is 3 minutes and 40 seconds. This shows that most users took their time to explore the information on the dashboard. Furthermore, it showed that in total 6637 actions are performed on the dashboard. Saving personal specifications is the most performed action with 39% of the total amount, followed by 28% for adding trainings to the calendar and 24% for specifying the results of a training. So these aspects take 91% of all actions on their behalf, which is expected because these actions are related to the design criterion data capture. Only one action is only performed twice, namely adding training categories in the profile page. Hence, it was probably not found by the users.

V. Conclusion

In this paper we showed how a user-centered, rapid-prototyping methodology helps to take the Quantified Self barriers [1], [2] into account. A dashboard for triathletes is designed and evaluated with in total 25 triathletes and fourteen regular persons. We did not address the first barrier (**B1**) as this problem is not relevant for triathletes. They want to train, so they make time and according to our survey, already all triathletes reflected on their progress. Motivation (**B2**) is provided through the possibility to compare the progress with other peers, yet this seemed insufficient. Entering data into the dashboard is too cumbersome, which resulted in the fact that there is not enough data to actually compare between peers. Automatic synchronization with other wearables could address this problem. Based on the results of the final questionnaire, we can, however, conclude that the dashboard is a suitable visualization tool (**B3**), helps the triathletes to analyze data (**B4**) and collects data from different sources into one dashboard (**B5**). The "tracking too many things" barrier (**B6**) is addressed through our rapid prototyping methodology; where we refined the elements on the dashboard to the essential elements. Finally the last barrier (**B7**) of insufficient scientific rigor is taken into account by the survey with 66 triathletes and the possibility to incorporate context is included based on the think aloud interviews. We furthermore showed that the developed dashboard gives an added value to triathletes for both ease and needed time in solving assignments that relate to the goals of the dashboard.

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