Badge Architectures in Engineering Education
Blueprints and Challenges

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Keywords: Badge Architectures, Achievements, Gamification, Motivation, Reputation, Engineering Education.

Abstract: The paper presents a critical discussion of badge architectures and an illustrative case study. We argue that common glosses of badges as simplistic or as extrinsically motivating are misleading when designing or evaluating badge architectures. We propose to focus on their descriptive and creative effects: badge architectures may create user portraits, system maps, and dedicated timelines, supporting new forms of attention within the system and at meta-system levels. By affording new activities in and about the system, badges can offer participants resources to internalize their extrinsic motivation. Our case study illustrates the complexity of minimalist badge architectures, presents two innovative features, and discusses challenges in implementation.

1 INTRODUCTION

In this paper we critically review and reformulate arguments concerning the use of badges, and we propose orienting concepts for designers of instructional systems. There is a rich thread of literature dedicated to badges and related reward systems in digital games; nonetheless, their use in education, and particularly in engineering education, has been rather understudied. Badges are mainstream components of digital games, and they are increasingly used in non-game contexts and in boundary systems (serious games, gamified applications, games with a purpose). This increasing interest in badge architectures reflects two converging trends: on the one hand, their continuous evolution and growing importance in gaming, and, on the second hand, the expanding relevance of games as models and resources for the design of other systems.

The paper is organized as follows: in the next section we define badge architectures and discuss their key features and rationales; we then discuss specific issues concerning badges in educational settings, and we present a case study to illustrate some of our key points. We conclude by proposing a new set of concepts to guide reflection on the design and evaluation of badge architectures.

2 BADGE ARCHITECTURES

We use the concept "badge architectures" instead of simply "badges" in order to underline one of our main arguments: badges are valuable as components of a system of rewards, related, in turn, to a system of activities. Awareness of the systemic functioning of badges is a key consideration for the design process.

Seen from a critical distance, badges may seem a simple or even simplistic mechanic. Still, successful badge architectures often balance multiple objectives and combine heterogeneous elements to create smooth user experiences. Their apparent simplicity is, at its best, a sophisticated achievement of design and evolution.

2.1 Key Features

We cover by the term "badges" a variety of rewards, including "achievements", "medals", "trophies", "pins" etc. Some of the key features shared by these rewards are: a title, an icon, a description and related points (Galli and Fraternali, 2012). Badges are virtual artefacts that are granted to participants, who thus become their owners. If we extend the description of badges to include their role in the system, we can say that, as a rule, a badge shares the following characteristics:

RughiniÈŹ R..
Badge Architectures in Engineering Education - Blueprints and Challenges.
DOI: 10.5220/0004388405480554
In *Proceedings of the 5th International Conference on Computer Supported Education* (CSEDU-2013), pages 548-554
ISBN: 978-989-8565-53-2

1) A **graphic sign**: as a rule, badges have a core graphical descriptive component, which may be complemented with additional elements such as text, numbers, and/or other graphical elements (for example, several stars);
2) A reference to a specific **system event** resulting from the user's activity; this may be an accomplishment of a valuable task, a chance finding, a noteworthy failure (for anti-achievements), a memorable experience etc. The event is, as a rule, succinctly described through the badge title and possibly through an accompanying phrase; badges may allow observers to reach (via hyperlinks) a more elaborated description of the underlying activity and performance;
3) After it is unlocked, the badge is attached to the **participant's profile** in the system and, possibly, transferred in other systems as well;
4) Badges rely on a **quality vs. quantity** play: they are virtual possessions, and, as such, can be either possessed, or not. Still, badges may be further quantified (by counting them, or by summing achievement points), thus becoming again commensurable on a continuum.
5) Badges often are **secondary rewards** (Montola et al., 2009), meaning that the game can be played without paying too much attention to them; nevertheless, many players consider the secondary achievements a critical game element (Jakobsson, 2011).

a. Rationales

Badges in digital games are diverse. Montola et al. (2009) identify several types, ranging from rewards for exploring the game (tutorial) and completing game activities (completion, collection) to badges for outstanding achievements (virtuosity, hard mode, veteran, loyalty, paragon), for eccentric events (special play, curiosity, luck) and to meta-gaming (fandom). This diversity makes visible several functions of badge architectures in digital games: they show the way, they render visible certain activities and stimulate participation, and they encourage prolonged engagement with the game. From the point of view of game designers, achievements are especially valuable insofar they retain players longer in the system. Antin and Churchill (2011) point to five other functions of badge systems: 1) instruction about possible activities, 2) goal setting, 3) reputation – including information on players' experiences, skills, interests, and overall dedication to the game, 4) conferring status, and 5) group identification. They go on to highlight two topics for further reflection: badges are not motivational for all participants, and they may even have adverse effects by displacing intrinsic motivation.

Given the diversity of participants, the diversity of possible badges, and uncertainty concerning motivational effects, how are designers to tackle the task of deciding whether a given badge architecture is adequate, and how to implement it?

We propose to distinguish between two functions of badge architectures that are analytically distinct while depending on one another for functioning: a **descriptive** mission, and a **creative** mission.

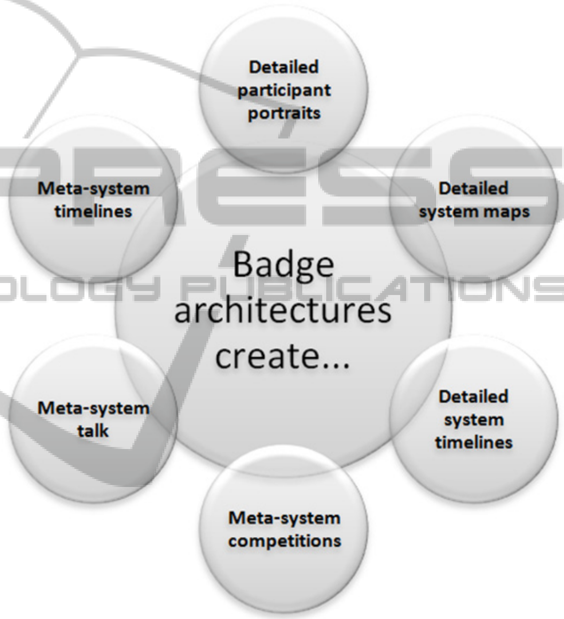


Figure 1: Creative effects of badge architectures.

On the one hand, badge architectures function to **map the system** of activities (game or non-game) to which they are attached. Badge architectures also function to **portray** participants, making their experiences, skills, and inferred preferences available to others, in a system of coveillance (Jakobsson, 2011). One step further, by specifying valuable activities and outcomes in the system, and by making participants visible to one another, badge architectures allow a "**Gestalt understanding**" (Antin and Churchill, 2011) of the system and its community.

On the other hand, through this descriptive effects, badges afford novel **activities within** the system and **about** the system (such as various metagaming activities – Sotamaa, 2010), and new sets of **reasons** for engaging with the system. In his ethnographic work on Xbox 360 gaming, Jakobsson distinguishes three main types of users in relation to achievements: achievement casuals (enjoying them now and then for their scaffolding function), hunters (aiming for the largest overall score), and completists (aiming for an integral achievement collection) (Jakobsson, 2011). We identify, through his analysis, three creative effects of badge architectures that apply to games and possibly to other systems as well. On the one hand, they add a **resistance structure** to the gameworld, by making salient the less visible regions of the game, by structuring gameplay time, and by extending the duration of gameplay beyond the first game end. Secondly, badges create a **new definition of game completeness**: they compose a collectable set that invites a new type of activity: "collecting badges". Thirdly, as Jakobsson notices, badges may create **a different (meta)game** whatsoever out of a series of initial games: he concludes that players of the Xbox 360 console games have become, with variable awareness and willingness, participants in a multi-player online game in which each achievement represents a distinctive "quest".

A focus on the descriptive and creative missions of badge architectures allows us to overcome the heated debate on whether badges foster **intrinsic or extrinsic motivation**. Badges are often denounced as depleting activities of their fun, displacing intrinsic motivation, or making it irrelevant, at minimum. Laschke and Hassenzahl (2011) join a trend of denouncing badges (and other instances of gamification) as meaning-depleting stimuli that enforce a behaviorist theory of human motivation (Robertson, 2012; Hecker, 2010; Bogost, 2011). Still, their argumentation does not rely on empirical evidence on how badges are actually taken over by participants. They notice that "becoming a "mayor" of a place can be solely driven by the wish to get the according badge (…) there might be a big difference between being there because of an intrinsic interest in the people, the place, the atmosphere or being there because of the badge" (Laschke and Hassenzahl, 2011, p. 3). While this difference certainly *might* obtain in some instances, empirical research and testimonies concerning Foursquare users / players point out that many of them have multiple reasons for using the system, beyond collecting badges (Lindqvist et al., 2011) – even when cheating in the game (Berne, 2012). Jakobsson replies to the intrinsic vs. extrinsic discussion that badge collecting is in itself an intrinsically motivated pursuit – but this does not directly address the issue of whether the joy of collecting decreases the joy of playing or otherwise engaging with a system. Jakobsson notices that, in practice, there is a deep ambiguity of players concerning achievements. They can be experienced as stimulating, as addictive, as alienating, or as informative and quasi-inert – depending on the game the participants actually play, within the formal system frame (ibid.). The question then becomes not whether badges support or displace intrinsic motivation, but **what kind of novel activities are afforded by badge architectures**, how are they taken over by participants, with what kinds of reasons, and with what consequences? These questions can only have specific, empirical answers, depending on the social context of the activity.

3 BADGES IN EDUCATION

Badge architectures in educational systems may be **embedded into a gameful system** (see for example Fitz-Walter, 2011), or may be used as **independent game-like mechanics** to animate non-game learning activities, as in the examples of the Khan Academy and the future MITx framework (Young, 2012), in Mozilla Open Badges (Goligoski, 2012) or in the RSS Network (Ross et al., 2012).

Unlike gameplay that is, more often than not, voluntary and driven by enjoyment and other forms of individual fulfilment, students often experience educational activities as dry and tiresome beyond enjoyment. Therefore, the issue of intrinsic motivation displacement is less salient for badges granted in non-game learning systems. The problem becomes, rather, one of attention focus, for instructors and students as well. Badge-fuelled instructional systems may be accused of being lazy: do badge architectures stimulate instructors to create relevant, engaging learning experiences, or do they rather relieve them of this pressure? Do they stimulate learners to seek the hidden logic and relevance of unfamiliar notions, or just to navigate the surface of the subject matter and collect badges?

On the other side, badge architectures promise significant motivational effects for potential recipients – be they students or teachers. Final, outcome-badges are especially valued for their **descriptive** force: unlike diplomas, they are specific about underlying experiences and skills, and they can be displayed immediately after they are 'unlocked', making personal growth visible on a continuous basis (Young, 2012). Badges provide a form of fast (if not immediate) feedback, and they offer resources for self-presentation in front of peers and employers. Unlike badges in digital games, which are of interest mainly for other gamers and designers, badges in educational systems can speak to a larger set of publics, including potential employers in various fields, peers, and family members who may belong to different generational and occupational worlds. Educational badges may function, therefore, as **boundary objects** (Star and Griesemer, 1989; Halavais, 2011), translating formulations of skills and experiences to support interaction across domains of expertise.

There is another reason to consider the motivational force of badges in education. At finer levels of task granularity, badges that reward intermediate progress or secondary performances make the participant more aware of, and invested into the system. The **self-determination theory of motivation** (Scott Rigby et al., 1992; Ryan and Deci, 2000) downplays the intrinsic / extrinsic distinction and brings forward the issue of internal versus external source of motivation. Insofar badges offer pretexts for engaging with an activity, moments of fun that give some impetus for tackling a difficult task, they become antidotes for procrastination. Badges may function as tools for internalizing extrinsic motivation, enhancing participants' self-determination. Learners often appreciate that study tasks are useful and relevant – but they may lack a here-and-now impetus for actually starting the work. Getting the work started, for reasons intrinsic or extrinsic to that activity, is the first step towards developing better appreciation of a competence field, a first and necessary step towards autonomous learning. Badge architectures can therefore be designed not as promoters of intrinsic motivation, but as a **scaffold** for what Ryan and Deci (2000) call **internalized extrinsic motivation**, which we think of as a quasi-intrinsic motivation.

The third reason for considering badge architectures as motivational tools derives from their creative effects. Badges can consolidate learning by producing structures that extend beyond the here-and-now of instruction:

- Architectures of badges create **maps of learning fields and communities of practice** (Lave and Wenger, 1991). Therefore, they may support a better understanding of what is relevant in a specific field, and they can encourage convergence between different stakeholders in formulating the curriculum: human resource experts in the industry, K12 and university professors, and students;
- Unlike the too-official grades, badges "give concrete evidence for bragging rights" (Jarvinen, 2009) through detailed participant portraits, and thus stimulate **conversations** around learning; badges can also support consistent **contributions** on forums, peer-learning and content generation;
- Grades are only for students, but badges are for students and teachers alike, linking them in **horizontal social networks**; this is particularly relevant given the opportunities of social web for education (Trauşan-Matu et al., 2009);
- Badges afford comparisons between students and teachers from different course years, crossing classroom and generational time borders; they create **extended timelines**;
- Badges create **communities** of members that are attentive to one another's progress and even compete in educational arenas.

4 CASE STUDY: RL Hit List

In order to illustrate some challenges in designing badge architectures, we present the "RL Hit List". We have designed this system for students in the Computer Networks course (abbreviated as CN, in translation as RL) taking place in the 3rd year of study in a Computer Science program of a European technical university. The course enrolls around 100 students. The Hit List is already in use: its first 21 badges were awarded to course instructors and organizing team members, and the next 25 badges will have been awarded by the end of the first semester, in February 2013. The objectives of this badge system are:

1) To assemble **communities** of students and teachers:

- To create a visible, public, and course-related merit-based elite of students, including around 25% of each generation;
- To create a trans-generational record of performance, linking instructors and students from different years in a common network;
- To raise interest in computer networks and in the CN course among top performing students, and to recruit future student mentors and TAs;
- To position the CN course as a meaningful, challenging learning experience for students, instructors and employers alike – and in this process to consolidate the identity of the CN instructor team, and the research group in which they belong;

2) To stimulate technical and casual **talk** referring to computer networks and the CN course

- To make student performance throughout the course a public matter and a topic for conversation – that is, to create what Jarvinen aptly called "evidence for bragging rights" (2009) related to the CN course concepts, participants, and memories;

this evidence can become a topic in students' talk with their colleagues, and also in interactions with significant others from other professional fields, including family members and friends;

- To stimulate joint reflection in the faculty group – as teaching assistants are the ones who deliberate and vote on the students that receive badges for their laboratory and overall contributions.

- To position performance in the CN course as an 'experience that makes a difference' in students' CVs and when interviewing for jobs in the IT&C industry;

3) Last but not least, to **motivate** students to engage with course, laboratory, and forum activities, to raise their interest for participating in attendance-monitoring systems (Bucicoiu and Țăpuș, 2013), and for obtaining top grades in midterm and final examinations.

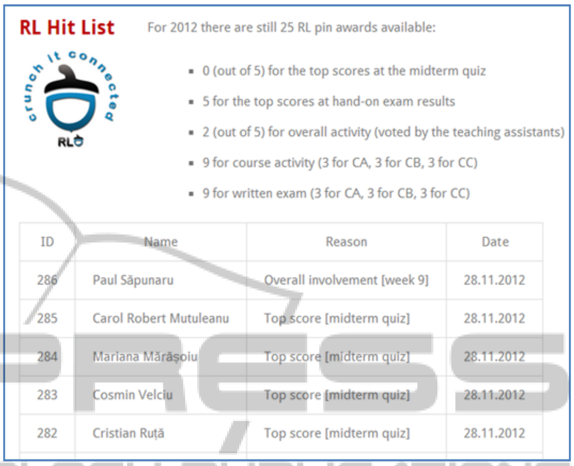
The RL Hit List falls squarely in the set of badge architectures, but it has two distinctive traits:

- It combines digital and material rewards: each prize consists in a digital inscription and a metallic pin badge (Figure 1), which is ceremonially awarded at the beginning of a course;

- Instead of images, it uses numbers as visual signs (Figure 2): each recipient receives an ID number on the Hit List, in increasing chronological order. The initial number was 256, the first value to symbolically evade representation on one byte. ID numbers do not represent scores or levels, but marks in time – which, at the same time, serve to construct a distinctive timeline and a tradition in reference to the CN course. The system displays a minimalist graphic, aimed at a community of professionals, with no explicit reference to gamefulness or playfulness.

Figure 2: Metallic pin badges for the RL Hit List.

The allocation of RL pin badges is not entirely automated, depending, for some categories, on instructors' deliberation. As a consequence, this award architecture has immediately produced a new kind of **awareness** of possible and alternative criteria for appreciating student contributions to classroom and virtual discussions. In order to be able to make their case, members of the course team have had to pay more attention and to remember more of their students' activity in class, by name. Although it seems that teaching assistants and course professors would anyway remember outstanding students, setting this as an objective visibly refines the granularity of the remarkable contributions.



RL Hit List

For 2012 there are still 25 RL pin awards available:

- 0 (out of 5) for the top scores at the midterm quiz
- 5 for the top scores at hand-on exam results
- 2 (out of 5) for overall activity (voted by the teaching assistants)
- 9 for course activity (3 for CA, 3 for CB, 3 for CC)
- 9 for written exam (3 for CA, 3 for CB, 3 for CC)

ID	Name	Reason	Date
286	Paul Săpunaru	Overall involvement [week 9]	28.11.2012
285	Carol Robert Mutuleanu	Top score [midterm quiz]	28.11.2012
284	Mariana Mărășoiu	Top score [midterm quiz]	28.11.2012
283	Cosmin Velciu	Top score [midterm quiz]	28.11.2012
282	CristianRuță	Top score [midterm quiz]	28.11.2012

Figure 3: The online RL Hit List at 28.11.2012.

While virtual badges are swiftly allocated by system administrators, metallic pins are awarded festively, in front of around one hundred colleagues. Still, this feeling of ceremony is volatile: we have noticed that, when granting three identical pins (top score in midterm quiz), the first student to be announced has received intense applause, while the third was barely applauded – at a distance of seconds. Therefore, the most challenging aspects that need to be managed concerning the offline pins are not the material issues per se (designing, ordering, depositing etc) but the symbolic issue of creating and maintaining their **ritual** dimension.

We have initially assumed that the purpose and functions of this badge architecture are transparent for all participants, students and teachers alike, in virtue of the simplicity and self-explanatory nature of the system, and a shared gaming culture. Subsequent discussions have indicated that this was not the case: the only objective which featured prominently in members' talk was "to motivate students to be more engaged with the course". This is why we have decided to make the architecture more **verbose** – that is, to publish explicit self-descriptions for some of its rationales. This digital loquacity of the system was organized as a hypertext, with increasing layers of details aimed at different publics.

Last but not least, if there is a shared keyword across most objectives, it is **talk**. Badges are designed for conversation: they are alive if students, professors, employers end up discussing them one way or another. Students can contribute to course discussions, can "brag" about their achievements, can mention them in their online presentations; faculty members can talk about them as a noteworthy feature of their course, and as a personal accomplishment. Still, all this talk is only a possibility, until it really happens. The most difficult task of this achievement architecture is **to kindle its conversational infrastructure**.

5 CONCLUSIONS

Badge architectures are an increasingly relevant component of learning experiences. Engineering education is especially inclined towards using achievement-type rewards, due to widespread engagement with the gaming culture. We argue that the conceptual framework for reflecting and evaluating badge architectures relies on two common, but problematic, tropes: that badges are **simple** mechanics added to an activity, and that they operate within the **intrinsic / extrinsic** motivation dichotomy. Instead, we propose that badge architectures can be more productively thought of in light of their **descriptive and creative functions** for the system in which they are implemented. In brief, badges are productive elements: they can generate **maps, portraits, timelines**, and they open up a **meta-system level of activity**. At their best, badge architectures may help participants internalize extrinsic motivations for study and work, and they may open a communication space centered on the experiences and skills that they reward.

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