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User Experience, Gamification, and Performance

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Introduction

Computers and the Internet are used to master a broad variety of tasks. One major challenge is to make user interfaces usable, enabling effective and efficient work processes (see Hanrahan & Carroll, 2017; Chapter 3 in this volume). Another significant challenge for researchers is understanding and improving human–computer interaction based on an experiential perspective: users' subjective impressions and feelings, and resulting consequences for users' work performance (see Bargas-Avila & Hornbæk, 2011; Hassenzahl & Tractinsky, 2006). This chapter focuses on the experiential perspective to answer emerging questions such as:

- How do subjective experiences affect work performance?
- Are appealing and aesthetic website designs beneficial or harmful?

We distinguish between the indirect effect of an appealing design on learning and working performance and a more direct effect of motivating people with game-based concepts applied to working interfaces. Game-based approaches are an aspect of user experience capable of directly enhancing performance. Researchers have only recently begun to study the best ways to enhance work performance via appealing or motivating interfaces, and we provide case examples of best practices in the field, discuss practical implications, and point to directions for the greatly needed research in this area.

User Experience

Many businesses highly value digitalization and Internet user experiences. In part 210 of the ISO standard 9241, titled "Ergonomics of Human–System Interaction," the International Organization for Standardization broadly defines user experience as users' perceptions and

The Wiley Blackwell Handbook of the Psychology of the Internet at Work,
First Edition. Edited by Guido Hertel, Dianna L. Stone, Richard D. Johnson, and Jonathan Passmore.

responses toward actual or anticipated use of interactive products, systems, or services (ISO, 2009). The term covers the use or expected use of a wide range of digital products and interactive systems, such as software and Internet tools. Moreover, user experience is a multifaceted construct influenced by several factors, such as design factors, interaction characteristics, and subjective appraisals (e.g., Lee & Koubek, 2012; van der Heijden, 2003). The components of user experience model (CUE model) (Thüring & Mahlke, 2007) helpfully categorizes these factors (Figure 5.1) by describing how interaction with a system (which is influenced by the system's properties) and user and task/context characteristics might influence key user experience outcomes. Instrumental qualities such as usability, and non-instrumental qualities such as aesthetics, both evoke emotional reactions and influence appraisals. The CUE model is derived from experimental data (see Thüring & Mahlke, 2007) and supports the idea that user experience depends on the interplay between emotions, perceptions, and evaluations during interactions with technical systems or interactive products. From an organizational perspective, the consequences for work behavior, performance, and outcomes are an important interest.

The CUE model categorizes the main dimensions of the human–computer interaction within any technical system. With respect to the World Wide Web, three core constructs are essential to the current research on user experiences: content, usability, and aesthetics (e.g., Cober, Brown, Levy, Cober, & Keeping, 2003; Schenkman & Jönsson, 2000; Tarasewich, Daniel & Griffin, 2001; Thielsch, Blotenberg & Jaron, 2014).

Content is of prime importance when using the web, especially in work settings. ISO standard 9241–151 defines web content as "a set of content objects" on a web user interface, and describes a content object as an "interactive or non-interactive object containing information represented by text, image, video, sound or other types of media" (ISO, 2006, p. 3). Besides such objective characteristics (see Thielsch & Hirschfeld, under review), subjective experiences of web content are also essential, especially in business settings (Huizingh, 2000; Palmer, 2002). These subjective perceptions of web content depend on characteristics of the reader, purpose of website use, and a website's domain and specific content.

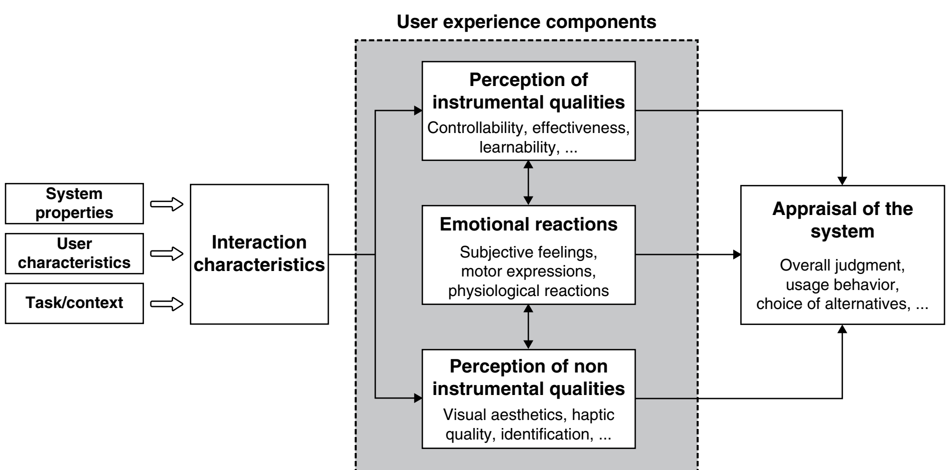

Figure 5.1 Components of the user experience model (CUE-Model). *Source:* Adapted from Thüring & Mahlke (2007).

Usability is a well-known construct of web user experiences (see Shneiderman & Plaisant, 2009; with respect to measurement issues, see Hornbæk, 2006). It is defined, based on ISO 9241–11, as the "extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (ISO, 1998, p. 2). Usability and ergonomics of Internet-based tools are discussed in Chapter 3 of this handbook (see Hanrahan & Carroll, 2017). Here we focus on an experiential perspective on the Internet and digital products at work (see Bargas-Avila & Hornbæk, 2011; Hassenzahl & Tractinsky, 2006).

Aesthetics, beauty, and pleasure are among the non-instrumental experiential factors of website experience (Lavie & Tractinsky, 2004; Moshagen & Thielsch, 2010). The generic term aesthetics is often described as an immediate pleasurable subjective experience (Leder, Belke, Oeberst, & Augustin, 2004; Moshagen & Thielsch, 2010; Reber, Schwarz, & Winkielman, 2004). Users can quickly perceive, process, and evaluate the aesthetics of a web site – often within a split second (e.g., Lindgaard, Fernandes, Dudek, & Browñ, 2006; Thielsch & Hirschfeld, 2012; Tractinsky, Cokhavi, Kirschenbaum, & Sharfi, 2006; Tuch, Presslaber, Stöcklin, Opwis, & Bargas-Avila, 2012). Aesthetic evaluations influence several outcomes such as preferences, trust, and even user urges to buy impulsively or intentions to revisit websites (see Moshagen & Thielsch, 2010). High aesthetics lead to user satisfaction (e.g., Lavie & Tractinsky, 2004; Lindgaard & Dudek, 2003; Tractinsky, Katz, & Ikar, 2000) and influence subjective perceptions of usability (e.g., Thielsch, Engel, & Hirschfeld, 2015; Tractinsky et al., 2000; Tuch, Roth, Hornbæk, Opwis, & Bargas-Avila, 2012).

The content of an Internet tool or a given website is often determined by the target group and is task related, as well as being determined by a specific context. Thus, most approaches on Internet content involve specific situations or specific aspects of content (e.g., its actuality, availability or reliability, see Thielsch & Hirschfeld, under review). Consequently, developers must analyze and optimize content in relation to individual circumstances. The same applies to usability, which is at best optimized in a way that the user experiences no problems. The fact that enhanced functionality of an interactive tool increases performance is rather trivial. However, how do non-instrumental qualities (such as aesthetics) affect work performance? Can game-based design enhance user performance? In the following sections, we discuss current understandings of these issues. We use the term *aesthetics* to refer to the appeal, beauty, and attractiveness of, and the pleasure experienced when visiting a website or using an interactive system.

Effects of user experiences on performance

How do Internet users' subjective experiences affect work performance? Do emotions and moods interfere with organizational performance goals? Can aesthetics harm performance? Early user experience research stressed that workplace computer systems are meant to enhance efficiency, not to give pleasure. Some authors even argued that aesthetic designs interfere with work goals (e.g., Andre & Wickens, 1995; Hollnagel, 2003) and objected to favoring aesthetics over usability (Norman, 1988). Further research has altered that perspective. For example, Norman (2002) argued that aesthetics positively influence problem-solving cognition and performance by changing emotional states.

We conducted a systematic literature search, applying several search terms (such as "user experience," "aesthetics," "design," and "emotional design," combined with the term "performance") in several scientific databases (e.g., the Association of Computing Machinery [ACM] digital library, Google Scholar, Web of Science). Additional publications were found by searching the cited references in the studies retrieved through the systematic search. Publication lists of prominent researchers working in the field were also individually checked for papers on the subject. Studies were only included in the systematic review if distinct performance measures had been applied; other publications were dropped (e.g., when participants only subjectively rated their performance and no objective measure was used). Thus, our review finally included 46 studies on non-instrumental user experience qualities and performance (Table 5.1, Table 5.2, and Table 5.3). Most of the studies have included student samples; field studies, systematic reviews, and meta-analyses are as yet lacking. However, extant research has tested a broad variety of variables and tasks, and here we summarize the current state of knowledge in this area.

Research provides mixed findings about performance effects of design variables. At present, we lack wide-ranging advice on enhancing Internet workers' performance, but many studies offer promising suggestions for specific tasks and situations (Table 5.1, Table 5.2, and Table 5.3). Only a few studies suggest design variables deteriorate performance (i.e., Gnambs, Appel, & Batinic, 2010; Sauer & Sonderegger, 2011; Sonderegger, Uebelbacher, Pugliese, & Sauer, 2014; van Schaik & Ling, 2009). Thus, there seems to be no general conflict around designing websites and Internet tools that are both usable and enjoyable.

Many studies have focused on design variables of interactive systems and websites that indirectly affect user behavior (however, this chapter will also describe a more direct approach in the context of game-based approaches). To date, there is little evidence regarding which theory best explains the effects. Researchers have provided a range of explanations, such as mediation by positive affects (Norman, 2002), increased motivation due to prolonged joyful experiences (e.g., Sonderegger & Sauer, 2010), or effects caused by reduced cognitive effort in processing (e.g., Szabo & Kanuka, 1998). Additionally, different effects might interact in determining user experiences.

Furthermore, researchers distinguish learning performance from task performance. Users pursuing learning goals focus on increasing their competence and knowledge; users pursuing performance goals focus on outcomes, favorable judgments, or high scores (see Elliott & Dweck, 1988; Locke & Latham, 2006; Seijts & Latham, 2005). Users with learning goals are expected to gain deeper understandings, take their time, and make mistakes as a natural and important part of learning. In contrast, work situations usually require employees to find the best and fastest task solutions, without making mistakes. Although not all work situations are stressful or are meant to be a test experience, regular work days often leave little time for learning or making mistakes. Nevertheless, learning is important for job performance, especially for working smart through acquired knowledge rather than working hard (e.g., Seijts & Latham, 2005). The effects of design variables in learning scenarios are quite positive, as we will see in the next section.

Table 5.1 Overview of studies addressing user experience and learning performance.

Effects	*Authors*	*Typical design variables*	*Typical performance measures and effects*
No effect	Hall & Hanna (2004)	Color	Retention
Partial positive effects	Heidig et al. (2015), Plass et al. (2014), Szabo & Kanuka (1998)	Balance, color, shape, unity, general appeal/aesthetics	Comprehension (+), recalled information, response time, retention, transfer
Positive effects	Miller (2011), Pomales-García, Liu, & Mendez (2005), Strebe (2016), Um et al. (2012)	Background, shape, icons, color, contrast	Comprehension, pages retrieved, time spent learning (+), recalled information, transfer

(+): Positive effects on a specific performance measure in more than one study.

Table 5.2 Overview of studies addressing user experience and task performance.

Effects	*Authors*	*Typical design variables*	*Typical performance measures and effects*
Negative effects	Sauer & Sonderegger (2011), Sonderegger et al. (2014)	Color, symmetry, general appeal/aesthetics	Task completion time, number of commands needed to fulfill task
No effect	Ben-Bassat, Meyer, & Tractinsky (2006), Hartmann et al. (2007), Ilmberger et al. (2008), Katz (2010), Lee & Koubek (2010, 2011), Nakarada-Kordic & Lobb (2005), Nordeborn (2013), Schmidt et al. (2009), Sonderegger et al. (2012), Thielsch et al. (2009), Thüring & Mahlke (2007), Tractinsky et al. (2000), Tuch et al. (2012)	Background, color, font, layout, shape, symmetry, texture, general appeal/aesthetics	Task completion time, number of clicks/inputs, number of errors
Partial positive effects	Bonnardel, Piolat & Le Bigot (2011), Quinn & Tran (2010), Reinecke & Bernstein (2011), Sauer & Sonderegger (2009), Sonderegger, Sauer, & Eichenberger (2014)	Color, general appeal/esthetics	Task completion time, number of clicks/inputs, number of errors, amount of used information
Positive effects	Douneva et al. (2016), Sonderegger & Sauer (2010)	Color, pictures, text-picture-ratio, general appeal/aesthetics	Number of correct answers, task completion time, number of commands needed to fulfill task, number of errors

Table 5.3 Overview of studies addressing user experience and performance in testing tasks and under stress.

Effects	*Authors*	*Typical design variables*	*Typical performance measures and effects*
Negative effects	Gnambs et al. (2010), van Schaik & Ling (2009)	Color	Task completion, test score (–), number of correct answers
No effect	Chawda et al. (2005), Douneva et al. (2015), Ling & van Schaik (2006), Salimun (2013)	Color, general appeal/aesthetics	Task duration, number of errors, number of tasks solved
Partial positive effects	Cawthon & Vande Moere (2007), McDougall et al. (2016), Moshagen et al. (2009), Reppa et al. (2008), Reppa & McDougall (2015), Salimun (2013), Salimun et al. (2010)	Color, shape, visual complexity, general appeal/aesthetics	Response time (+), number of errors
Positive effects	Tuch et al. (2009), van Schaik & Ling (2008)	Visual complexity, general appeal/aesthetics	Reaction time, number of correct answers

(+): Positive effects on a specific performance measure in more than one study.
(–): Negative effects in more than one study.

Learning performance User learning requires time for acquiring new information, understanding how to use a system, or finding solutions to a specific problem. Eight publications on user experience and learning in our review investigated reading and response times, comprehension, recall, retention, and knowledge transfer. Most found at least partial positive effects of interface design variables (Table 5.1). Besides general appeal, the use of specific colors leads to positive outcomes. Pleasant designs encourage users to spend more time reading information material, which increases their retention and comprehension. Several possible reasons have been discussed, for example, effects of emotions and motivation (e.g., Heidig, Müller, & Reichelt, 2015; Plass, Heidig, Hayward, Homer, & Um, 2014; Um, Plass, Hayward, & Homer, 2012) or the idea that good designs enable automatic processing (Szabo & Kanuka, 1998), reducing learners' mental effort and perceived stress (Miller, 2011). Thus, interactive and web-based learning environments should be created in a way that facilitates positive user experiences.

Task performance Our search strategy yielded 23 studies on typical working tasks with computer applications, systems, or websites. The tasks were somewhat comparable with everyday work tasks: researchers asked participants to acquire information or to use an application or interactive system for data entry, communication, or system queries. Two studies clearly had negative results and two had positive results (Table 5.2). Most other studies found interface design variables to have partially positive or no effects on task performance. Color or general appeal were the most commonly studied variables, but no clear effect pattern emerged. Several studies discussed a possible weak manipulation of investigated design variables; others conjectured there may be moderating factors that are currently unknown. Additionally, some of these studies did not focus on performance or examined only one aspect of performance, sometimes including merely a manipulation check. In sum, aesthetic and appealing designs usually do not harm task performance. Instead, well-designed digital work environments can enhance task performance even in everyday tasks such as search, use, or information input.

Performance in testing and under stress Many digital workplaces have stressful work demands requiring rapid and competitive work. We found 15 publications investigating effects of pleasant interface designs in such tasks (Table 5.3). Study participants were often required to work as fast as possible or to answer test questions. Again, only a few studies found negative effects of design variables while several publications reported at least partially positive results. For instance, the color red has been found to detrimentally affect the performance of men in tests of general knowledge (Gnambs et al., 2010). The authors discuss the possibility of stereotyped threats in achievement contexts. In contrast, several studies on icon and interface design found that low visual complexity or applying general aesthetic design principles positively affected response times. Possible explanations included performance gains caused by positive emotions according to mood mediation theory (Norman, 2002) or reduced cognitive effort caused by more aesthetic designs. In conclusion, color effects are essential when designing for stressful or test situations, and well-made designs can support job performance. Regarding icon design, McDougall, Reppa, and colleagues provide helpful insights (see, e.g., McDougall, Reppa, Kulik, & Taylor, 2016; Reppa & McDougall, 2015). These authors present several icon examples and empirical findings on appeal, familiarity and visual complexity, which can be directly applied for improving existing icons or the creation of new ones.

Exemplary study: Positive effects of optimized user experience

Miller (2011) used an online tool designed to help instructors assess student learning in American Sign Language (ASL) to investigate whether an aesthetically optimized design would influence learning and performance in e-assessment environments. Students were asked to perform tasks such as re-telling a short story or describing a photo or a picture. They had to perform the tasks in sign language and present the solution on their webcam. The online software recorded the answers. Students voluntarily self-assessed their recorded performance using the original media and several self-evaluation items. This learning environment was designed to address the educational and technical needs of assessments within the ASL curriculum (see Miller, Hooper, & Rose, 2005). Miller (2011) aesthetically optimized the original online tool without changing functions, task objectives, or media. For example, saturated colors were used for buttons, texts, and time bars; the background was changed from white to neutral gray; drop shadows were placed behind screen content. Miller based the design changes on Norman's (2004) visceral, behavioral, and reflective levels of emotional design. Basic color and background changes aligned with the visceral level. Animated time bars and text tickers rather than numerical timers addressed the behavioral and reflective design levels.

Miller (2011) randomly assigned 66 students with some ASL experience to the original or the redesigned version of the online tool. Both groups performed the same tasks and answered the same questions, leading to several interesting findings. First, the students evaluated the redesigned tool as more aesthetic but not more usable. That is, the aesthetic manipulation was effective but without change or decrease in experienced usability. Second, the more aesthetic version decreased perceived mental effort, stress, and task demands. Third, students who worked with the more aesthetic version reported greater satisfaction and willingness to continue using the tool. All findings were associated with at least medium but mostly large effect sizes. The self-assessment time was nearly doubled among students using the aesthetic version, and these students also showed significantly higher ASL task performance scores (given by external raters). Qualitative student interviews confirmed that aesthetics had positive effects, especially with respect to satisfaction. Furthermore, students who used the original version often complained about the difficulty and inappropriateness of tasks for their level of ASL experience. Students using the optimized aesthetic version experienced tasks and level of difficulty as appropriate.

In sum, Miller (2011) showed how an optimized aesthetic design not only influences subjective perceptions and satisfaction of users but also impacts on voluntary learning time and objective performance scores. Thus, this research exemplifies best practice in designing online learning tasks in educational settings, in personnel development, and in professional training. However, all the studies and results discussed so far have relied mostly on design variables to indirectly affect performance through positive user experiences. In contrast, it might be preferable to motivate users directly through, for instance, "gamification." That is, gamification can be understood as one specific aspect of user experience dedicated to motivate users through game elements.

Gamification

Gamification, which is growing in popularity, applies game elements to non-game contexts to make computerized and nondigital systems, services, and activities more enjoyable and motivating (Deterding, Dixon, Khaled, & Nacke, 2011). In the service industry, gaming experiences create overall value for users (Huotari & Hamari, 2012). Gamification, also called game-thinking (Marczweski, 2015), emphasizes game-oriented designs rather than game mechanics (Niesenhaus, 2014a). Game-based learning (Prensky, 2001), serious games (Michael & Chen, 2005), games with a purpose (von Ahn, 2006), and gamification all use game elements and technology to generate benefits beyond pure entertainment. However, the design processes are challenging. Many projects fail because serious applications are often incompatible with games, and achieving compatibility is sometimes commercially nonviable.

Rather than building whole games, gamification puts playful mechanics into non-game contexts in a more flexible and cost-efficient way. Although gamification means that game elements are integrated into non-game applications, unfortunately, often the only game elements used are virtual awards through point lists, high-score tables, or badges attached to established products or processes. In many applications, simply adding game elements has not yielded the expected benefits. The market research company Gartner estimates that 80% of gamified applications fail to meet their business objectives primarily because of poor design (Pettey & van der Meulen, 2012). Further challenges include diverse user needs and motivation, as shown by research into play personas (an approach based on fictional characters of typical users, see, e.g., Bartle, 1996; Canossa & Drachen, 2009) and research into user preferences, needs, and frustrations (Marczweski, 2015). Furthermore, gamification frameworks have focused on motivations and needs in relation to typical game elements. The Octalysis framework (Chou, 2015) offers eight core drivers for human motivation such as meaning, accomplishment, and unpredictability. For example, a game awards points, badges, progress bars, and leaderboards to fulfill users' desire to progress, develop skills, and overcome challenges. Werbach and Hunter (2012) use a pyramidal gamification framework: low-level components are at the base, followed by mechanics, while higher-level dynamics are at the apex. Components include tangible mechanics such as points, leaderboards, boss fights, and virtual goods. Mechanics move the system forward and generate player engagement (e.g., challenge, competition, feedback, and rewards), whereas dynamics are the highest level of abstraction and comprise fundamentals such as emotions, narratives, and progressions. Such frameworks have provided initial explanations of user motivation and game elements, but the research community is still in need of a reliable and validated model to describe gamification effects. The early approaches also lack a closer connection to motivational psychology theory, which makes it difficult to validate them. Closing this gap will be one of the most important and challenging tasks of future gamification research.

However, gamification potentially optimizes participation, engagement, and commitment (Herger, 2014; Schering, Niesenhaus, & Schmidt, 2014). In business and working environments, gamification can increase the attractiveness of companies and their products, enhance process efficiency, and optimize customer relations (e.g., Werbach & Hunter, 2012; Zichermann & Linder, 2010). Consequently, the number of published gamified business applications has considerably increased over the past years, and includes the team-based challenges to find errors in Microsoft Office (McDonald, Musson, & Smith, 2008) and a community network at SAP (Kumar & Herger, 2013).

Effects of gamification on work performance

Researchers have studied effects of gamification on work performance in areas such as education (Denny, 2013; McDaniel, Lindgren, & Friskics, 2012), online communities and social networks (Cramer, Rost, & Holmquist, 2011; Thom, Millen, & DiMicco, 2012), health and wellness (Cafazzo Casselman, Hamming, Katzman, & Palmert, 2012; Fuchslocher et al., 2011; Stinson et al., 2013), sustainability (Gnauk et al., 2012; Y. Liu, Alexandrova, & Nakajima, 2011), orientation (Depura & Garg, 2012; Fitz-Walter, Tjondronegoro, & Wyeth, 2012), and marketing (Downes-Le Guin, Baker, Mechling, & Ruyle, 2012). Seaborn and Fels (2015) discussed theoretical foundations used in gamification frameworks, including self-determination theory (Ryan & Deci, 2000a), intrinsic and extrinsic motivation (Ryan & Deci, 2000b), situational relevance (Wilson, 1973), situated motivational affordance (Deterding et al., 2011), universal design for learning (Rose & Meyer, 2002), transtheoretical model of behavior change (Prochaska & Marcus, 1994), and Norman's user-centered design (2002). Motivation is assumed to have the most positive effect (see Hamari, Koivisto, & Sarsa, 2014).

As gamification is an emerging field, currently few studies have examined gamification effects on work performance. Although businesses are increasingly applying gamification projects, they often keep their efforts confidential, hence again few company-related studies are publicly available (Seaborn & Fels, 2015). Work-related gamification examples thus come from software development (Farzan et al., 2008; Kumar & Herger, 2013; McDonald et al., 2008), software evaluation (Eickhoff, Harris, de Vries, & Srinivasan, 2012), and crowdsourcing (Y. Liu et al., 2011; Mason, Michalakidis, & Krause, 2012) applications. Most of those work-related gamification systems are based on standard elements such as points, badges, and leaderboards, which are easily applied but represent only a small selection of potential gamification elements (Deterding et al., 2011). Table 5.4 summarizes findings on work-related gamification effects, and lists the applied gamification elements and performance measures.

Microsoft's popular Windows Language Quality Game illustrates how gamification positively affects work performance. The game encouraged native language speakers within the company to perform the expensive work of traditional software localizers; more than 900 voluntary players found 170 bugs across all 36 native language editions of Microsoft Windows, thereby providing a cost-effective way to improve product quality (McDonald et al., 2008). Unfortunately, the benefits were not compared with benefits of non-gamified testing methods.

SAP's community network is an often-cited case of fostering engagement in the customer and developer communities by the introduction of basic gamification mechanisms such as points and levels (see Kumar & Herger, 2013). SAP used active community members to provide feedback for fine-tuning its gamification system. In 2013, two months after SAP introduced the changes, it reported a 1113% increase in comments on content creation and a 250% rise in community feedback (Kumar & Herger, 2013). Even before SAP applied gamification elements to its community network, IBM gamified "Beehive," its internal social networking website, with a point and status interaction. Employees were highly motivated to increase contributions, but the effects were not sustained (Farzan et al., 2008).

Bagley (2012) used gamification elements such as points, ranks, and badges to encourage users to participate in a crowdsourcing task. The gamification elements did not attract all users in the same way: older users who had less general interest in gaming reported fewer positive experiences. Eickhoff et al. (2012) asked users to participate in a relevance assessment by relating keywords to concepts. Limited game rounds, a points system, progress visualization, high scores, and leaderboards gamified the application and yielded significantly higher annotation efficiency. Mason et al. (2012) used points and badges to engage users in a human computation task and reported mixed results: the gamified application motivated participation and thereby improved recognition of algorithms, but the gamification elements interfered with the quality of results. Other studies have also

Table 5.4 Overview of gamification studies by effect, applied gamification elements, and performance measures.

Effects	*Authors*	*Gamification elements*	*Performance measures and effects*
No effect	Y. Liu et al. (2011)	Points and scoring system	No significant changes in user behavior
	Witt et al. (2011)	Points and activity counter	Similar participation as in prior studies, lower impact than expected because of unclear presentation
Partial positive effects	Bagley (2012)	Points, ranks and badges	Encouraged participation (+); performance varies depending on age and game interest (−)
	Mason et al. (2012)	Points and badges	Engaged users and improved algorithms (+); interfered with quality of results (−)
	McDonald et al. (2008)	Point and scoring system, team contest	Positive results in participation and error reporting (+) but not in efficiency or effectivity compared with a similar non-gamified process (−)
	Grant & Betts (2013)	Badges	Positive effects on user participation in community network (+)
	Farzan et al. (2008)	Points and status system	Higher motivation to contribute and increased contribution (+), reduced effects over time (−)
Positive effects	Eickhoff et al. (2012)	Limited game rounds, points, progress visualization, leaderboards	Higher annotation efficiency and quality (+)
	Kumar & Herger (2013)	Ranks, points, progress visualization	Significant increase of community network activity (+)
	Niesenhaus (2014b)	Team scoring, progress visualization, playful time management	Improved process efficiency, higher rate of problem reporting and problem-solving (+)
	Flatla et al. (2011)	Playful visualization	Similar to standard calibration procedures but more enjoyable and strongly preferred (+)

(+): Positive effects on a specific performance measure.
(−): Negative effects.

found ambiguous effects of gamified elements. Y. Liu et al. (2011) implemented a point and scoring system in two software applications but found no significant changes in user behavior. Witt, Scheiner, and Robra-Bissantz (2011) found a tendency towards positive changes in behavior but lower-than-expected impact of gamification elements because the presentation was unclear.

Production and management scenarios offer further promising applications that may have high economic impact. Next, we present a case study highlighting the use of gamification elements in an industrial production setting (Niesenhaus, 2014b).

Case study: Gamifying industrial production

This case study was conducted in a lamp-producing facility. Industrial assembly requires that machines are always functional. Operators and maintenance personnel must collaborate to achieve optimal throughput, high-quality products, and minimal downtimes. Production requires both flexibility and quality control. For this reason, most gamification mechanisms presented in this case study focus on operators and their activities, although gamification interventions are also appropriate in other departments such as management, sales, and plant engineering. A confidentiality agreement with the client dictated use of stylized plastic models to describe the scenario rather than images of the real production facility (Figure 5.2 and Figure 5.3). Our ability to show the screen contents of the operator stations was also restricted. Each operator had at least one screen at their station to show the next production step, and offered interactive elements to flag production errors, and incorporated gamification elements.

The operator stations were aligned with the production machines, so the process flow was streamlined, and offered several constraints. First, the low agency among the employees was a limitation in the implementation of motivational and playful elements. The design team considered these constraints and looked for games that share qualities with the industrial application. They were inspired by games that have simple and repetitive interaction, such as "FarmVille," the physical interaction with little freedom in "Dance Dance Revolution," and the simple touch gestures with maximal impact of "Infinity Blade." The team devised several motivational and playful elements to maximize employee autonomy and agency and to avoid potential harm from direct competition and control (Niesenhaus, 2014b). The gamification design follows the Lean UX interaction design approach (Gothelf & Seiden, 2013), an agile software engineering approach that focuses on personas and scenarios, and generated assumptions according to their criticality for product viability. To minimize the risk of failure, small experiments or questionnaires are recommended to validate the most relevant assumptions (Gothelf & Seiden, 2013). This design approach allows fast iterations of gamified software prototypes and adapts well to the agile development process used by most software companies.

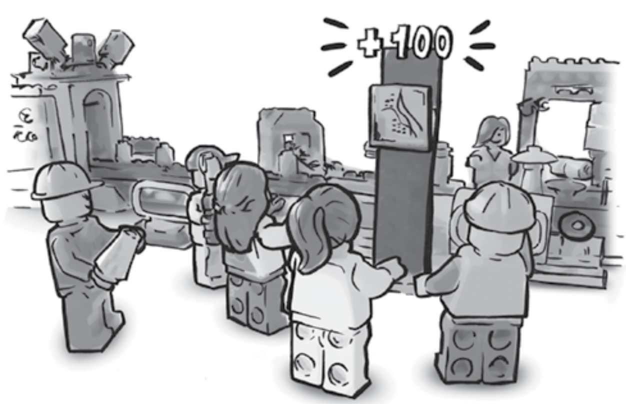

Figure 5.2 Stylized model of a shift team watching their daily score (Niesenhaus, 2014b). *Source:* With kind permission of Niesenhaus.

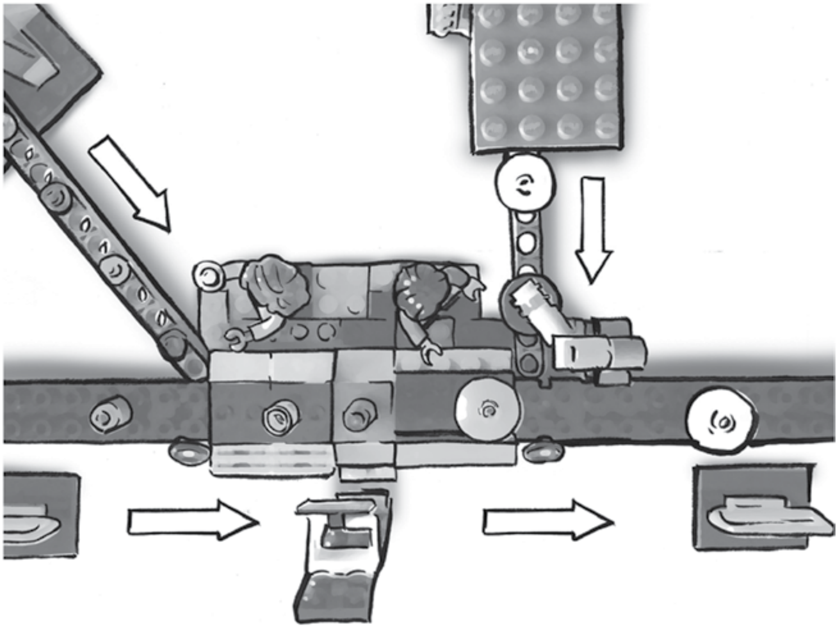

Figure 5.3 Stylized model of optimized collaboration in a lamp production unit, achieved by synchronizing the movement of the various operators (Niesenhaus, 2014b). *Source:* With kind permission of Niesenhaus.

Team score The design team observed and interviewed production team members and learned that they had strong social bonds and were willing to help each other. The team chose to use a team-oriented score system rather than introducing potentially harmful competitive elements (Figure 5.2). Each production line operator generates team points by performing actions such as boxing lamp parts, suggesting ways to optimize the workflow, and checking quality. The team score encourages efficiency and supports other team members. When team members log out of their shifts, they are asked, for example, to choose the most valuable colleague of the shift, or identify which station is the most difficult to handle. Answering voluntary questions gives the team extra points.

However, the teams do not compete with each other. Instead, each team views daily team scores compared with past scores and all-time high scores. We observed that operators reacted positively; they discussed their reasons for and ways to improve their daily scores. Once or twice a year, the company connects teams from other company locations in different countries for a week-long competition including daily videoconferences between locations so that operators around the world socialize with each other and exchange knowledge. The competition is between company branches, not within a local branch, and is designed to encourage socialization and efficiency.

Idle time Gaming elements also managed work breaks. As 10–12 operators work in parallel, if four or more take work breaks at the same time, production is significantly lowered. Operators can use their touch-screen terminals to request break times. They have the option to take immediate breaks but can also adhere to the system's suggestions for optimal beginning and ending time to minimize impacts on the assembly line. When operators agree to suggested break times, they receive 3–15-minute bonuses, which are directly added to their break allowance. The bonus is based on an algorithm that calculates potential reduction in production time when an operator takes an immediate break. The higher the potential reduction, the greater is the bonus time that can be earned.

Team rhythm Some assembly processes required two or more operators to collaborate. The design team observed that two operators work together to assemble three lamp parts. The operator who is second in line must adjust to their partner's working rhythm. At one step (Figure 5.3), the second operator makes a 90° turn to check the quality of the lampshade before assembly, momentarily losing track of their partner's progress. They then waited for their partner, which frequently generated inefficient idle times.

The team evaluated various types of visual and acoustic feedback tools to provide the second worker with immediate feedback about the first operator's production progress. They finally chose to use an LED-powered progress bar that showed the assembly progress in three steps: start, in assembly, nearly ready for take-over. The display was based on optical sensors that recognized hand movements. The progress feedback minimized waiting times. Another positive side effect was that the tool revealed which operators shared similar rhythms or better fitted the roles of first or second operator. The team leader used the information to choose better placements, making the process more efficient and enhancing workers' role satisfaction.

Results Early findings of an analysis of long-term effects of the gamification interventions were promising (Niesenhaus, 2014b). Over one month, data were collected on efficiency (throughput, average duration of downtimes), quality rate (number of rejected products during quality control) and user feedback (based on questionnaires) of one production line with a gamification system and one without the intervention. Although operators of the gamified production line could choose to use the system or deactivate it at each operator terminal (with no impact on team score), 85% used it. The gamified production line had 6% higher average throughput and 12% lower downtimes in comparison with the non-gamified production line. Quality rate tended toward positive, although the results were statistically insignificant. User feedback based on short questionnaires during terminal logout revealed significantly higher motivation, knowledge exchange, and social interaction among the operators.

Psychological Processes Affecting User Performance

So far no distinct evidence is available to show which model or theory best explains the observed findings. Early user experience research suggested that good design enhances performance by reducing cognitive processing efforts (Szabo & Kanuka, 1998), allowing faster detection of visual objects, caused by less complexity and more coherence in good designs. Good designs promote automatic processing, whereas bad designs induce less-efficient manual processing. In addition, perceptions of content quality are driven by halo effects of good designs, leading to greater attention by or higher motivation in users (Szabo & Kanuka, 1998). Building on these ideas, researchers have discussed attentional effects of good design (e.g., Reppa, Playfoot, & McDougall, 2008) and other cognitive effects in website perception, such as mental models, bottom-up perception processes, visual complexity and prototypicality (e.g., Douneva, Jaron, & Thielsch, 2016; Tuch, Bargas-Avila, Opwis, & Wilhelm, 2009). Tractinsky and colleagues (2000) introduced the "what is beautiful is usable" approach to human–computer interaction research and proposed attitude effects such as halo effects, stereotypes and affective responses to aesthetic designs as driving processes. Several studies were in agreement (for an overview, see Tuch, Roth et al., 2012), but others have argued that aesthetic pleasure is the result, not the cause, of processing dynamics. Processing fluency theory (Reber et al., 2004) assumed that the more fluently a user can process an object, the more positive is his or her aesthetic response. Thus, "what is beautiful is usable" may have a reversed connection under certain conditions (see Tuch, Roth, et al., 2012). Human–computer interaction research must still solve this kind of chicken-or-egg causality dilemma.

Norman (2002, 2004) proposed a mood mediation model: good design and aesthetics influence cognition by evoking positive emotions. Thus, aesthetics can improve performance and compensate for usability problems, particularly in creative and problem-solving tasks. Users who feel good about the system will overlook design flaws. Several researchers have followed Norman's theory (e.g., Moshagen, Musch, & Göritz, 2009; Quinn & Tran, 2010; Reppa & McDougall, 2015). In addition, emotional design has positive effects in learning contexts (e.g., Plass et al., 2014; Um et al., 2012). But evoked emotions might be relatively weak or short-lived (e.g., Douneva, Haines, & Thielsch, 2015; Katz, 2010) and Norman's theory still lacks validation.

Motivational effects are often discussed, in particular, in learning or gaming scenarios. Game elements are especially known to generate enjoyable and interesting settings that engage users for long periods (Plass, Homer, & Kinzer, 2015). Thus, several user experience researchers adhere to the prolonged joy/increased motivation hypothesis (e.g., Heidig et al., 2015; Sauer & Sonderegger, 2011; Sonderegger & Sauer, 2010). That is, users prolong their enjoyment with aesthetically appealing products (partly, instead of directly solving given tasks) and perform better by entering flow situations (see Csikszentmihalyi, 1977) in which they perceive their skills to be congruent with challenges in engrossing activities. In gaming, they experience flow when their attention is focused such that they feel a compelling sense of being present in a mediated virtual environment (Liu & Chang, 2012). Furthermore, motivation and flow are essential preconditions for engagement. The engagement model captures the close relation between user motivation and cognitive, affective, behavioral, and sociocultural engagement, largely depending on the context, the user, and the game (see Plass et al., 2015). As research has little focused on engagement, the model is based on the INTERACT model of learner activity (Domagk, Schwartz & Plass, 2010; [INTERACT, Integrated Model of Multimedia Interactivity]). Future application of such models in user experience research appears promising.

In sum, research is just beginning to unravel the non-instrumental aspects of interface design and effects on performance. Causes and effects such as attention, cognition, and emotion may act in combination. Applying playful elements might increase task motivation due to higher engagement and flow experiences. Nevertheless, existing research already highlights several practical implications.

Practical Implications

To optimize user experiences with Internet tools at work and to allow decision-makers to choose among the available products, first we need to know how users experience a product. Research has provided several reliable and valid measures for such an inquiry, especially regarding general user experiences: The AttrakDiff questionnaire (Hassenzahl, 2004; Hassenzahl, Burmester, & Koller, 2003) employs 28 pairs of adjectives to measure pragmatic quality, identification, stimulation, and appeal of an interactive product. Evidence of reliability and validity of the tool is available (for further information, see www.attrakdiff.de). Another measure using a semantic differential is the User Experience Questionnaire ([UEQ], Laugwitz, Held, & Schrepp, 2008; Laugwitz, Schrepp, & Held, 2006), which consists of 26 items representing attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty. (For information about reliability and validity see www.ueq-online.org.) A more recent measure is the meCUE questionnaire (Minge & Riedel, 2013; Minge, Riedel & Thüring, 2013) based on the CUE model (Thüring & Mahlke, 2007). The instrument has 34 items in four modules: instrumental and non-instrumental product perceptions, emotions, consequences, and overall evaluations. Evidence regarding reliability and validity has been provided (see www.mecue.de).

Few scientifically validated measures are available for measuring aesthetics. Lavie and Tractinsky (2004) developed the first standardized multiscale measure for assessing subjective aesthetics of websites. The instrument includes two five-item scales reflecting classical and expressive aesthetics. The authors found evidence for reliability and for convergent, divergent, and concurrent validity. More recently published, the Visual Aesthetics of Websites Inventory ([VisAWI], Moshagen & Thielsch, 2010) is an 18-item questionnaire that measures a general aesthetics factor consisting of four facets: simplicity, diversity, color, and craftsmanship. The authors found evidence for high reliability as well as convergent, divergent, discriminative, concurrent and experimental validity. A short four-item version, the VisAWI-S (Moshagen & Thielsch, 2013) is also available as well as information about optimal cut points (Hirschfeld & Thielsch, 2015), and a manual (for further information, see www.visawi.de). A sound measure would assist in decisions regarding whether to invest in new tools, systems, or websites, or to build new ones or relaunch existing ones. Table 5.1, Table 5.2, and Table 5.3 might help determine specific design factors that can account for performance improvements. But research has yet to elucidate causal relationships between design variables and performance outcomes. Thus, ultimately, a well-skilled trusted designer is essential (Chevalier & Ivory, 2003; Park, Choi, & Kim, 2004).

Before developing a gamified system, in particular, developers should set a clear mission statement, which can be recalled if needed. Will the game elements be used to strengthen customer loyalty, to increase user motivation, or to make processes more efficient? Almost as important is choosing how to measure achievement. When and how will a given goal be achieved, and can it be quantified? Questionnaires and interviews with customers and employees, pre/post studies comparing efficiency data, or investigating data quality are reasonable methods for examining achievement (Herger, 2014; Niesenhaus, 2014b).

Generally, game elements can be used to create high situational interest (Rotgans & Schmidt, 2011), but not to enhance unattractive mechanics (Plass et al., 2015). That is, game elements cannot enrich every process. Sometimes the underlying process has to be redesigned before game elements can be integrated. All stakeholders should participate in a redesign to represent different perspectives and implications. Prototypes should be available early to investigate functionality of game elements (Fullerton, Swain, & Hoffman, 2004; Salen & Zimmerman, 2004; Schell, 2014). Experiences from game development highlight the importance of testing game mechanics as soon as possible. Most companies do not have professional game designers and hire external expertise for process, analysis, and idea generation. Individuals who are experienced in game design and who possess additional skills in user experience design and/or interaction design can aid balancing game mechanics and the general user experience.

Future Research

Researchers are just beginning to study the effects of experiential variables on user performance. Further studies should identify main variables and investigate causal relationships. Additionally, existing results should be summarized in systematic reviews and meta-analyses. Objective design factors should be systematically linked to subjective perceptions (e.g., Miniukovich & de Angeli, 2015; Seckler, Opwis & Tuch, 2015) and underlying perception processes (e.g., Leder & Nadal, 2014; Thielsch & Hirschfeld, 2012). Research on performance effects should be embedded in a theoretical framework, ordering performance goals, tasks, application characteristics, and design variables. Published reports of field approaches are also urgently needed to verify research results under real conditions of practice. The same is true for gamification studies, especially in the work environment. The number of publications is increasing, but most applications and studies are in areas with no direct impact on daily work routines (Hamari et al., 2014; Seaborn & Fels, 2015). Some insights have been gained about gamified systems in education (Denny, 2013; McDaniel et al., 2012), health and wellness (Cafazzo et al., 2012, Stinson et al., 2013), and orientation (Depura & Garg, 2012; Fitz-Walter et al., 2012). We can transfer those findings to work scenarios, but our knowledge of gamification effects on work performance requires more application to and studies from real work environments. Furthermore, the research community needs more mature theoretical models and frameworks on gamification effects. Although we have frameworks for game mechanics (Werbach & Hunter, 2012; Yu-Kai Chou, 2015) and early approaches to user types (Marczweski, 2015), developing comprehensive models and frameworks is essential to broaden future research.

In addition, it will be interesting to investigate further and extend results of existing user studies into the areas of performance and user experience. For example, some interfaces can automatically adapt to users' cultural preferences (see Reinecke & Bernstein, 2013), which should have consequences for the workplace. Good interface design may contribute not only to satisfaction or performance but also directly to wellbeing (see Thieme, Wallace, Meyer, & Olivier, 2015), which is promising. Finally, technical innovations have triggered significant developments in the Internet in the past (e.g., Engholm, 2002) and will remain important for future developments and research, especially considering the rise of smart and connected products (e.g., Porter & Heppelmann, 2014).

Conclusion

User experience and gamification can enhance performance in Internet-based working contexts. When the right designs and appropriate gamification approaches are chosen, users will benefit from pleasant and joyful interactions with technical systems. Especially in learning contexts, positive user experiences relate to learning outcomes. Gamification can enhance productivity in classic online community environments (e.g., Kumar & Herger, 2013) and in production settings (e.g., Niesenhaus, 2014b). However, more basic and applied research is urgently needed to investigate underlying processes and causes. The Internet and related technologies are moving and developing targets, and the same applies to user experience and gamification research. The research reviewed in this chapter suggests a promising outlook for future possibilities in this field.

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