Title: "Synch with me": Rhythmic interaction as an emerging principle of experiential design.

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Abstract:
Emotion based research has accelerated in the area of product development and design, signaling a turning point in the pursuit of functional, or purely usability driven research approaches. At the heart of emotion design techniques is a desire to tailor deeper connections between users and experientially designed products and services.

As product design becomes increasingly competitive in the age of the iPhone, designers are required to create products that "synch" with users, maintaining the emotional bond with users as they complete their tasks, achieve pleasurability (Jordan 2000; Cayol and Bonhoure 2004) and user satisfaction (Han and Hong 2003).

This paper will explore a central element of successful emotionally engineered designs: rhythm. Rhythm will be explored as it exists biologically (Wild, Darrouzet, Kahn and Stucky 1995), socially (Bardram 1997; Reddy and Dourish 2002) and temporally (Spillers and Loewus-Deitch 2003) in the context of user interactions, emotions and product appraisals (Desmet 2002).

Introduction

Rhythm is an under-looked area of usability, emotion and product research (Knowles 1998), yet as this paper will show, it represents a key element in emotion design and user-product interaction. Only recently has rhythm been paid serious attention (Begole, Tang and Hill 2003), resulting in new efforts at 'rhythm modeling' (Fisher and Dourish 2003).

The need for designers to quantify the "synch" feeling is being recognized as a significant variable that can be incorporated into the user-product interaction design process (Knowles 1998). Hekkert, Mostert and Stompff (2003) found that in order for the user to "dance with the machine" the design requires "resonance". This paper will argue that it is the quality and presence of "synch" in its forms of resonance, flow and entrainment that is at the heart of every successful product interaction.

Beneath each instance of an emotionally sensitive design is a connection made with the user. Beyond aesthetics and appeal however, what is responsible for the persistent engagement that sustains user interaction? What unifying characteristic do successful designs employ? What creates loyalty or positive appraisal?

In this paper, I will argue that at the heart of all positive emotional interactions and appraisals can be found a distinct, yet subtle element that we can observe as synchrony. Synchrony or the feeling of being "synched"," comes from the rhythms that mediate cultural, social and personal tasks. Furthermore, synchrony can alter a user's sense of time and perception, leaving the user in a state of "cognitive absorption" (Agarwal and Karahanna 2000).

Product and service interaction is developing an emerging quality that embodies rhythmic interaction. Electronic payment plans such as London's Oyster card or supermarket self-checkout systems and virtual global teams in different time zones require positive "synching" in order to be successful at the transactional and team collaboration level. As a result, people increasingly want products, services and social spaces that "synch" with their goals, tasks and needs.

Rhythm in everyday life

Hall (1983) pointed to the fact that rhythm is so much a part of everyone's life that it goes virtually unnoticed. Rhythm is also overlooked in usability, emotion and product research (Knowles 1998), yet it represents a key element in emotion design and user-product interaction. Rhythm exists in every product interaction and is pervasive in everyday life (Reddy and Dourish 2002).

Rhythm is essentially neurological. Task performance causes neurons to fire in unison and the sum of the brain's action and dendrite potential form a 'cortical rhythm' according to Fehmi and Robbins (2001). The rhythms of the brain are governed by neural pacemakers that derive their rhythmicity from the inherent firing rate of the cells making up their circuit (Connor, 1985). Brown (1991) noted that the biological basis of rhythmicity in the brain and body appears to be generated by a small circuit of neurons called the suprachiasmatic nuclei (SNC) of the hypothalamus (Moore-Ede, 1982).

Cyphert (2001) noted that the ability to synchronize with the simplest rhythmic pattern begins at about three years, a learning process that is assisted by watching a moving visual target, as when a child imitates the rhythmic motions of community members (Kumai and Sugai 1997).

If observed and understood, rhythms can help coordinate and mediate social and task based performance. Interaction design that reflects an understanding of rhythm can feel more aligned, or in tune for the user.

Rhythmic interaction with the iPod

The iPod offers a superior music listening experience because of it's tactical (music is emotional and users must touch the wheel to find and play music). However, there are several areas where the iPod breaks rhythmic interaction. Axup (2006), provided an analysis of factors that needed improvement:

> Enlightened designers often try to get away from the standard squares and lines typical of computer interfaces. And that is fine when we are concerned primarily with aesthetics, but it is not necessarily good when we are concerned with ergonomics. Doing many small circles with your thumb isn't convenient - it's tiring. Furthermore if you listen to long DJ sets, or have 60 gigs of songs, you find yourself circling and circling and circling and…
>
> The other problem with the wheel is that it doesn't provide any haptic feedback while scrolling. That means that if you are in the song list mode and want to select a song two songs down from your current location, how do you know how far to move the scroll wheel to get to the desired location? You don't – unless you watch it. You will probably over shoot it, and have to go back a few items. This is because the circular scroll pad interface doesn't give enough feedback, which produces errors.

Further problems with the ipod occur when operating the software, the key area of 'synching' between music files and the device. Itunes can be frustrating and confusing to use—it is not clear to the novice how exactly to "synch" music without understanding how itunes inter-operates and where the "synch" button is located. A similar problem can occur when synching a smartphone, the device might fit standalone as a compelling experience, but without the cooperation of the synching software, the experience can be paralyzed. Of three smartphones they author has owned in the past few years, only one has maintained compatibility with the laptop operating system or drivers, therefore making the essential experience of 'synch' possible.

Brown (1991) noted that the *interactional rhythms* that manifest from nonverbal communication must be flexible for people to entrain to one another and strong enough to

maintain that bonding. The same is true for human-product interaction. How we interact with products and devices depends on how well the device understands the ebb and flow of our rhythms.

Capturing Flow

Flow is defined as "the state in which people are so involved in an activity that nothing else seems to matter" (Csikszentmihalyi 1990). Wild et.al (1995) pointed to the similarity between flow and cognitive absorption. Flow has also been described as *cognitive absorption* by Agarwal and Karahanna (2000); Tellegen and Atkinson (1974).

Flow may be a strong indicator (Csikszentmihalyi 1990) of a rhythmic user experience, though designers should be mindful of the significance of the 'sinkhole' areas in the interaction or experience design that lack flow. When a user interrupts or hesitates, gets confused or experiments (task interruption), there may be some useful cues regarding the creation and/or utilization of emotions used to generate new cognitive resources or feelings that solve problems, called "affective artifacts" (Spillers 2004).

Trevino and Webster (1992) argue that flow is an important element of human-computer interaction characterized by a sense of self-control of perception, a narrowing of attention, a heightened state of curiosity, arousal and intrinsic interest.

Csikszentmihalyi (1990) and Vallerand (1997) found that in order for flow to be present, a strong intrinsic motivation must also be present. Additionally, Krippendorff (2004), stated that intrinsically motivated actions are of a "self-sealing" nature, meaning action and the awareness of action merge into one.

Extending flow

Flow and synch are both defined by their temporal characteristic. Resonance is a key emotion design component (Hekkert, Mostert and Stompff 2003). A user experience of resonance is closely tied to flow and absorption states. Hummels et. al. (2004) experiments with "ISH" found resonance to be a key factor for engagement. However, the experimenters also asserted that resonance is not only temporal, but that "we resonate with products because we are people with certain needs, desires and intentions, a social

and cultural history and position etc" (266). Consequently users resonate differently to different products:

> "A resonant interaction is the result of a mixture of different ingredients like usability, human skills (cognitive, perceptual-motor and emotional), richness of the senses, individual and social needs, desires and interests, personal history, ways of acquiring the product, context of use (situation, timing, environment, social setting), aesthetics of interaction, intimacy, engagement and openness to find and create one's own meaning, story and ritual" (267).

Rhythms, then, can include cultural, social or environmental factors such as contexts, trends, or cultural signals (Ono 2006).

Staying in Synch

Emotionally sensitive product design involves understanding and designing to user rhythms in order to trigger flow or absorption and resonance states. For example, video game designers (Laurel, 1991) found that by increasing auditory stimulation (louder, faster sounds), users feel more excitement and their blood pressure actually increases. By designing sensory properties of an interface that manipulate social, emotional and biological rhythms, product designers can achieve greater synchronization of product to user as well as greater usability and desirability.

Understanding and mapping the rhythmic properties or requirements of a design requires paying close attention to the non-verbal or unconscious relationship a user has with a product.

Many designers often ignore the biological properties of a design with regard to the role of rhythm. Because rhythm is such a subtle force in human biological experience, it is often overlooked. Yet, rhythm as an important attribute in user productivity, social organization and task completion is well documented (Hill and Begole 2003; Bardram 2000; Zerubavel 1979).

Vetere et. al. (2005) found that users felt greater intimacy with a device that supports serendipitous synchronous communication by exchanging the message as well as a note

that a message is being composed (a similar feature employed by Instant Messaging programs that alerts users when a message is being composed).

Djajadiningrat et. al. (2002) discovered that a product's feedback and the user's action should coincide in time. If there is too much of a delay between action and product feedback, they are no longer seen as related.

Entrainment and user experience

Entrainment is a powerful element of achieving good "fit" with emotion design. Designs that by-pass user resistance, are said to synchronize with the user socially, anthropometrically and physiologically. Positive appraisals (Desmet 2002) result from products that entrain more strongly and consistently, in a way nonverbally communicating with the user with design elements such as system feedback, clear expectations, and feedforward systems (Djajadiningrat et. al. 2002).

For Turetzky (2002), "entrainment is the tendency for an oscillating body to synchronize or lock into phase with other oscillating bodies". Rhythms in this definition, embody the dual aspect of being organized while organizing the elements of the material or product. Entrainment, according to Turetzky (2002) and Strogatz (2003) creates order.

Entrainment holds tasks and users together. It acts as the binding agent or catalyst of flow and absorption experiences. While synchrony and entrainment appear to mean the same thing, they focus on different aspects of the same process. Synchrony is the manifest observable phenomena; entrainment refers to the internal processes that make this possible; i.e., the two nervous systems "drive each other". (Hall 1983).

Tajima (2004) in a pilot with a cleaning robot managed by a human, showed that utilizing entrainment can positively reduce the user's psychological burden or "smooth out" the bumps in the experience. Hence, interfaces that entrain users perform coordinating or ordering actions, bringing rhythmic processing into a coherent state.

Design Criteria for Entrainment

1. **Adjustable**: e.g. Adjusts to personal and cultural habits
2. **Discreet**: e.g. Makes subtle adjustments; User does not need to know what is happening.
3. **Seamless**: e.g. Works without extra steps; works in the background for the user (during and between use).
4. **Receptive**: Is sensitive to time and timing (transitions and breaks) (Begole et.al 2003).
5. **Responsive**: e.g. Sets expectation and provides active feedback.
6. **Incorporates time and tempo:** e.g. Paces the user, moves with the user.

Synching Services

Public transportation and transaction services have been revolutionized from paying fares to fetching tickets and opening lockers by RFID and/or electronic payment and transaction services or smart cards: Octopus (Hong Kong); Calypso/Navigo (Paris); KentKart (Izmir); Suica (Tokyo) and 65 more in use around the world (Wikipedia, 2008) . In London 80% of all journeys transact with the Oyster card, an RFID ticketing service, presumably the convenience of such "synch services" makes it easier for passengers and customers than the daily repetitive hassle of the manual payment experience.

Figure 1: London's Oyster card offers early morning commuters a "synch service"

However the Oyster card user experience is not without "synch" problems.

> "Oyster PAYG users on London Underground, DLR, National Rail and London Overground services are required always to "touch in" and "touch out" to cause the correct fare to be charged. This requirement is less obviously enforced at stations where there are only standalone Oyster validators rather than ticket barriers. Without a physical barrier, PAYG users may simply forget to "touch in" or fail to touch their card correctly, which will result in a penalty fare being charged. Equally, if the barriers don't function (reading 'SEEK ASSISTANCE') and the TFL operative has to open the gates manually, then the maximum fare may be charged. If this occurs a refund can usually be requested from a cashier". (Wikipedia, 2008)

Resonance with a machine involves alignment of cognitive, body and brain systems. For example, the above disconnects in the Oyster system, or absence of connection (Hekkert, Mostert and Stompff, 2003) can cause confusion, frustration, anger or dissatisfaction.

In order for rhythm to be sustained, "it must be synchronized to both the ongoing rhythm of the brain and the concurrent rhythm of the interaction" (Brown 1991, 64). Users must know what they are supposed to do and what to expect from that action. Implicit rules (business or technical) can cause unpleasant surprises, such as price over-charges or failure modes with such services.

In an evaluation of a supermarket kiosk in the USA, Spillers (2006) found that lack of explicit rules and an inability to 'back up' when loosing entrainment with the machine led to panic, frustration and chaos—with multiple users (typically four to a U-Scan checkout). A store supervisor operator intervention for minor breakdowns adds further social embarrassment or shame to the interaction, leading to a poor appraisal of the system, which is supposed to make shoppers lives easier (Figure 2).

Figure 2: A self-checkout system placed vegetable scanning codes on top of the machine in order to help users in addition to using a magnet with a list of additional codes hanging on the left of the touch screen. The manufacturers added the vegetable codes look-up to the frame around the touch screen and removed the hidden sheets. This improved "synch" with the machine, however requires placing items in the bag (often items are too light or do not require a bag, but force the user to pretend to place an item in the bag- which contains an undisclosed sensing device).

Synching global virtual teams

Global distributed teams are increasingly in need of staying in synch (Massey et. al 2003). Teams need a way to stay in synch, beyond current presence tools such as Instant Messaging. If teams can coordinate rhythms they are more like to stay in synch, yielding better team cohesion, productivity, accountability and participation (Begole 2003). Gibbs et.al (2005) referred to the ability of maintaining a connection as a phatic communication.

Often team leaders do not have a "finger on the pulse" (Reddy and Dourish 2002) and spend a lot of time contacting each team member to find out how things are going, what

problems team members are having and how the overall project is progressing and moving toward its goals (Logan 2008).

Experience Dynamics worked with a new start-up company (Logan 2008) to develop the Synchronizer, a web application aimed at aligning and coordinating teams distributed across multiple time zones (see Figure 3). Studies have shown that virtual teams that have strong work rhythms outperform those who are disconnected by "temporal patterning" (Masset et. al. 2003).

Conflict and a sense of distance are more prevalent on global distributed teams. Team bonding or resonance can improve team effectiveness. The time differences for teams create more perceived distance or lack of accountability. Montoya-Weiss (2001) found that temporal coordination improved conflict resolution with virtual teams.

A team's ability to predict team member availability and to coordinate temporally is an important process Begole called 'rhythm awareness' (2005). The Synchronizer provides a full transparency view of team member goals and tasks. It offers rhythm awareness through an ambient presence panel (top right) for users to set Status, Mood, Task progress perception and Overall project progress perception. The Mood/Status and "I'm currently…" settings provide a way for others to gauge interruption opportunities. The controls also provide a way for managers to stay in touch with employees, without imposing.

In addition, the Synchronizer offers a way to gauge actual progress through an audit trail of goal status, document movement and activity as well as Pending Requests- to allow team members to monitor and manage gaps, waiting periods and unnecessary delays- typically caused by the lack of communication or distance of not being able to walk over to the co-workers desk.

Figure 3: The Synchronizer: a global project team collaboration tool that incorporates passive and active participant/task monitoring to provide teams with better coordination and alignment of work rhythms.

The Synchronizer is currently being deployed and will be tested with global virtual teams in the field. The product aims to provide a way for teams to stay in synch and avoid productivity and communication bottlenecks.

Synching Work Rhythms

According to Hill and Begole (2003), users follow temporal patterns, called 'activity rhythms,' in their day-to-day work schedules. When users work together in the same space, they tend to become familiar with each other's rhythms over time. These temporal patterns can be extremely useful for predicting when a particular individual comes to work, takes breaks, when they are most receptive to unanticipated visits, and when they are typically available for working on certain types of tasks.

Zerubavel (1979) found ‘work rhythms’ and their social and temporal factors to impact worker productivity in the schedule driven hospital environment. Work rhythms according to Reddy and Dourish (2002), provide valuable information to other team members helping them accomplish their work as well as guide future activities.

Coordination activities play a major part in a team’s ability to synch their social rhythms and work rhythms (Bardram 2000). Begole (2007) demonstrated the ability to model and predict a distributed team member’s availability. By inferring team member’s rhythms, awareness of another’s temporal context is revealed. According to Begole (2003), ‘Exploring what information can be gleaned from the temporal context enables new applications in supporting the coordination of distributed teams’.

Conclusion

By understanding, observing and engineering designs with rhythm in mind, product designers can synchronize products more precisely to the user. In addition to increase one’s own awareness as a designer, including rhythmic attributes as design requirements will help designers embody emotion, through entrainment, absorption and flow more deliberately into product design.

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