

IMMERSIVE VIRTUAL ENVIRONMENTS: UNDERSTANDING IT'S INFLUENCE ON ORGANIZATIONAL ROUTINES

Research in Progress

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Abstract

Within the last 10 years richer 3-dimensional graphics have increasingly immersed users in virtual environments (VEs). Recently, immersion in VEs is also facilitated by cheaper and better head mounted displays. Immersion benefits individuals as well as organizations because it makes users feel as if they are physically present in the VE. This can reduce costs in industries heavily reliant on visualization, such as the architect, engineering, and construction industry. However, more immersive software and hardware does not necessarily lead to increased use in organizations, exemplified by the lack of organizations using virtual worlds and 3-dimensional computer aided software. While many IS scholars have focused on immersive VEs, the majority have looked into individual factors and applied methods, that are far from practice. Our research introduces theoretical lens of organizational routines and through initial interviews in four organizations, we investigate how the introduction of immersive VEs change organizational routines. We present four vignettes and propose a categorization enabling a better understanding of how artefact specificity and routine divergence influence the use of immersive VEs.

Keywords: Immersive Virtual Environments, Virtual Reality, Organizational Routines, Divergence.

1 Introduction

Virtual environments (VEs) have gained much attention in the last decade. Virtual worlds, have become popular and attracted millions of users due to, the use of rich 3D graphics. This rise in popularity sparked the interest of many businesses as they saw VEs as a tool that could improve, among other things, collaboration, knowledge sharing, and brand equity (e.g. Mueller *et al.*, 2011; Nah, Eschenbrenner and DeWester, 2011; Venkatesh and Windeler, 2012). 10 years later organizations interest in VEs is driven by cheaper and better head mounted displays which represents a development towards ever more immersive VEs. Immersion refers to a technology's capability to present a vivid VE to its user while shutting out the physical reality (Slater and Wilbur, 1997; Schultze, 2010). The development towards more immersive VEs, is relevant for many industries, because immersion can make users feel as if they are physically present in the VE, which in turn increases productivity, task performance, and collaboration between individuals (Csikszentmihalyi, 1991; Colbert, Yee and George, 2016; Cummings and Bailenson, 2016)

While many industries could benefit from more immersion it hasn't been used to the extent that was expected. For example, the use of 2D computer aided design (CAD) software is still the de facto standard in the in the architecture, engineering, and construction (AEC) industry while many major organizations, like Coca-Cola, Mercedes, and Reuters have stopped using virtual worlds completely (Nevo and Carmel, 2011; Nardon and Aten, 2012; Gal, Jensen and Lyytinen, 2014). Because of these initial and less successful attempts organizations have been reluctant to use immersive VEs (Yoon et al 2013). The introduction of new and more immersive technology, like head mounted displays, can potentially provide new possibilities for companies. But, as was seen with virtual worlds and 3D CAD software, an increase in immersive capabilities of VEs do not necessarily lead to organizations using them on a regular basis. Within the field of immersive VEs, IS scholars have looked into barriers for the use of immersive VEs (Goh and Yoon, 2009; Venkatesh and Windeler, 2012; Yang *et al.*, 2012). However, most research has focused on individuals and the adoption or use barriers for immersive VEs. To accommodate this gap, this study uses Pentland et al.'s theory on organizational routines (Feldman and Pentland, 2003; Pentland and Feldman, 2005) to investigate the changes that immersive VEs have on organizational routines by answering the following research question:

How does the introduction of immersive VEs change organizational routines?

This study contributes to IS research on immersive VEs by showcasing how the introduction and subsequent use of immersive VEs, in this case head mounted displays, influence organizational routines. We first show the influence that immersive VEs can have on organizational factors, thus, we argue for an organizational focus of research on VEs. Second, by showcasing the influence of VEs on organizational routines, we propose a categorization enabling a better understanding of how artefact specificity and routine divergence influence the use of immersive VEs.

The next section provides an overview of research on immersive VEs in the IS literature. This is followed by an introduction to organizational routines. Based on preliminary data collection from four organizations we then present four vignette which lead to the development of the proposed categorization. We conclude by discussing the proposed categorization and future research plan.

2 Immersive VE Research in IS Literature

Virtual environments (VEs) are digital spaces “...in which a user's movements are tracked and his or her surroundings rendered, or digitally composed and displayed to the senses, in accordance with those movements” (Fox, Arena and Bailenson, 2009, p. 95). Due to technological improvements of both software and hardware, VEs are becoming more immersive. Immersion is a VE's capability to present a vivid virtual environment while shutting out the reality in which the user is physically located (Slater and Wilbur, 1997). Since the start 90ies the increasing immersive capabilities of VEs can mainly be related to the software, which have provided users with a feeling of space by introducing 3D

graphics, which in turn increases the chance for users to feel physically present in a VE (Wirth *et al.*, 2007). Traditionally, hardware like PC monitors have been the norm in the AEC industry together with instruments like a keyboard and mouse to move around in the VE (Slater and Wilbur, 1997; Cummings and Bailenson, 2016). As a consequence, users do not get a feeling of being there, because the users field of view is not completely immersed and users have been relying on unnatural input methods to move around in the VEs which can lead to i.e. faulty building designs. However, due to recent developments in hardware, like head mounted displays and sensors that can track a user's movements, it is now possible to completely cover the field of view of the user while he or she can move around in a VE using one's physical body. This feels more natural as it mimics real life to a higher degree. Though, as mentioned, in the AEC industry less immersive 2D tools, monitors, keyboards as still considered the standard (Gal, Jensen and Lyytinen, 2014) and in other industries, virtual world participation is going much slower than expected (Venkatesh and Windeler, 2012). Like 2D CAD changed the AEC industry in many positive ways, so could the use of more immersive hardware, like head mounted displays. However, a literature of IS research on immersive VEs indicates, that the adoption and use of immersive VE has predominantly been investigated at the individual level. In addition, most studies in the field are quantitative. The Technology Acceptance Model by Davis (1989) is most frequently used model (e.g. Chen *et al.*, 2008; Vogel *et al.*, 2008). Later developments of the Technology Acceptance model, like TAM2 (Venkatesh and Davis, 2000) and the Unified Theory of Acceptance and use of Technology model (Venkatesh, Viswanath., Thong, James, Y.L. & Xu, 2012), are used as well (e.g. Goh and Yoon, 2009). In 2008 and 2009, when articles on immersive VEs initially started to surface focus was mainly on adoption and technical barriers i.e. too slow internet connections (e.g. Chen, Siau and Nah, 2008; Vogel *et al.*, 2008; Goh and Yoon, 2009). Later, perceived usefulness of immersive VEs, were identified as an important factor (e.g. Mäntymäki and Riemer, 2012; Schwarz *et al.*, 2012; Zhou *et al.*, 2012). More recently, IS scholars have looked into continuous use (Mantymaki and Merikivi, 2010; Mäntymäki and Riemer, 2012; Nevo, Nevo and Kim, 2012; Zhou *et al.*, 2012, 2015) and factors such as ease of use became more prominent (e.g. Junglas *et al.*, 2013). In addition, the feeling of being with others in a VE, often conceptualized as social presence or sociability (Biocca, Harms and Burgoon, 2003; Lee, 2004) (Mantymaki and Riemer, 2011; Zhou *et al.*, 2012; Iris Junglas *et al.*, 2013) has been identified as an important driver for use and/or continued use by individuals. The most frequently encountered factor encountered from reviewing the articles on immersive VEs is enjoyment (Goh and Yoon, 2009; Zhang, Kamal and Zigungs, 2010; Mantymaki and Riemer, 2011; Mäntymäki and Riemer, 2012; Nevo, Nevo and Kim, 2012; Schwarz *et al.*, 2012; Zhou *et al.*, 2012). Lastly, cognitive absorption, flow and immersion were, in itself, often deemed important factors that could explain use and/or continued use (Goel *et al.*, 2011).

Overall, the factors influencing individual adoption of immersive VEs provide important insights into why immersive VEs are not being used. However, these theories do not capture the organizational aspects. In addition, most of the studies are based on quantitative methods in laboratory experiments and surveys. As a consequence, the research has been done out of the context of the organizational life, potentially overlooking emergent organizational factors. We introduce organizational routines as an alternative lens, to help understand how organizational factors influence the use of immersive VEs.

3 Brief overview of Organizational Routines Literature

An organizational routine is a “*repetitive, recognizable pattern of interdependent actions, involving multiple actors*” (Feldman and Pentland, 2003, p. 96). It is the interdependent actions of multiple actors that make routines relevant to study in relation to immersive VEs as there is a need to understand the internal dynamics and relationships between not only one individual and an object, but how the individual interacts with the organization environment, the colleagues and the objects during daily work (Pentland and Feldman, 2005). For example, an architect's decision to use, paper and pencil or 3D CAD tools, is not only dependent on whether or not it's easy to use, but it also depends on organizational norms, previous experience with that or similar tools, the preferences of a potential customer – just to name a few. In the words of Pentland *et al.*: “*To craft good theory, we cannot rely on surface*

regularities and correlations; we need to under the underlying process” (Pentland and Feldman, 2005, p. 793).

We utilise the theoretical lens of organizational routines, to argue that the introduction of immersive VEs influence not only the individual but the organization as a whole. This is done by analysing the interdependent actions between individuals and multiple actors. The organizational routines not only allows to look at routines from an organizational perspective, but from the individual level as well. Organizational routines are mutually constituted by two components: abstract patterns and specific actions of the individual users. Abstract patterns are: “...*patterns that participants use to guide, account for and refer to specific performances of a routine*” (Pentland and Feldman, 2005, p. 795) also referred to as the ostensive aspect of routines. The specific actions, on the other hand, refer to the: “...*actual performances by specific people, at specific times, in specific places.*” (Pentland and Feldman, 2005, p. 795). The ostensive and performative aspects of routines are mutually constitutive as: “...*the ostensive does not simply guide performances (as a script guides a play); it is also created from the performances...*” (Pentland and Feldman, 2005, p. 795) and vice versa. In order to understand organizational routines, an additional element should be included, the artefact. According to Pentland et al. artefacts are the: “...*physical manifestations of the organizational routine...*” (Pentland and Feldman, 2005, p. 797) as routines, that exist in the daily organizational life, are often codified, prescribed, enabled, or constrained by certain artefacts like operating procedures, rules or best practices set out by the management. Thus, artefacts can also support or constrain any given routine. For example, an ideation routine is typically supported by a myriad of artefacts that support and enable this routine i.e. pieces of paper and pencils that can be used to sketch on. Even though organizational routines are often seen as a stable set of actions from the outside, the inner workings of routines, that is the relationship between the ostensive, performative and the artefacts that are used as a part of the routines, can be a source of great flexibility and change. In some settings this *divergence* between the parts may be beneficial to the operation of an organization. However, if an organization wants to use a new technology, the relationship between the ostensive, performative, and the artefacts involved in the routine needs to be consensual (Pentland and Feldman, 2005). If for example the management at an architect firm wants the employees to use immersive VEs to draw early sketches (the ostensive narrative), but they haven’t communicated it properly or the immersive VE is too difficult to use (the artefact), different ostensive narratives on how to use it arises. This also leads to increased flexibility in the newly formed sketching routine, which may not be embraced by employees. In turn they may not include the immersive VE in the sketching routine.

Theory on organizational routines allow us to investigate how the introduction of immersive VEs in organizations influences everyday activities. Using organizational routines, the unit of analysis is shifting from the individual use to the interdependent actions that involves multiple individuals. In this way, potential divergence between the ostensive, the performative, and the artefacts involved in the routine can be identified, which in turn can help to explain the limited use of immersive VEs.

4 Research Design

The research design built on qualitative methods and was divided into two phases. The first phase was explorative and we investigated processual changes, using interviews. We conducted interviews with four organization from the AEC industry that have been using immersive VEs as a part of their routines. Other methods like i.e. quantitative questionnaires were also considered during the first phase, but as the research question seeks to understand the processual changes, due to the dominance of variance studies and quantitative methods in the existing literature, exploratory interviews were preferred (Walsham, 2006). The first phase had two research objectives. First, to investigate how the companies introduce immersive VEs into their routines. Second, we aimed at gaining access to an organization in the AEC industry that use immersive VEs hence initiating the second phase. The second phase aims at better understanding the use of immersive VEs by conducting a longitudinal field study over a 6 months period in one of the architect companies visited during the first phase. The remaining part of

this paper will only focus and use data from the first phase, as the second phase is currently underway and we have not conducted the data analysis yet.

The four explorative interviews were collected by asking open ended questions. The length of the interviews vary from 48 minutes to 1 hour and 30 minutes due to the exploratory nature of the interviews. Those involved; a danish and a nordic general contractor, an architect company, and a product development company. We chose those organizations as have been quick in adopting immersive VEs due to their highly graphical mode of work. The interview with the danish general contractor was a focus group interview lasting 48 minutes. Four employees were present: two project managers that have experience with the use of immersive VEs and two employees that were responsible for the technical development of VEs. The interview with the nordic general contractor, lasted 1 hour and 10 minutes. Two employees were present: a general manager with use experience of immersive VEs and an engineer that developed 3D models for use in head mounted displays. The interview with the architect company lasted 46 min and the senior architect in charge of their use of head mounted displays was interviewed. Lastly, the interview with the product development company lasted 1 hour and 30 minutes, and the interviewee was the CEO of the company. During all of the interviews, except the interview with the danish general contractor, a head mounted display was present that served to demonstrate how they were using it in practice. Four vignettes were developed to describe how the introduction of immersive VEs influences sales routines which were the most commonly described in the interviews. The data was analyzed through the use of meaning condensation by going through the following two steps (Kvale, 2007; Walsham, 2006). First, meaning units (text samples), that represent a theme were extracted from the text. Second, data-theory links were made by comparing the meaning units with the concept of organizational routines. The data-theory links were subjectively qualified by the links ability to explain the research question: how the introduction of immersive VEs change organizational routines (Walsham, 2006).

5 Introduction of VE and Organizational Routines

In this section, the four developed vignettes are presented. They illustrate how the introduction of immersive VEs is not only affected by individuals but by multiple actors and objects that is the organization.

5.1 Immersive VE in a Danish General Contractor

A general contractor situated in Denmark offers services in the AEC industry covering all the phases of a construction project, from design to construction. Since 2012, they have been using VEs in the form of CAD software to sketch and design 3D models of buildings for demonstrations to the customers. Traditionally, 3D models were displayed on regular computer screen but, since 2015, they have been using head mounted displays to give customers an immersive experience. The interviewees showed a general excitement about the increased physical presence that that the immersive VE provide to customers during sales. One of the interviewees mentioned that the immersive VE provides a more physical experience to the customers referring to the fact that they can see around in a 3D model by moving their head – just as in real life. The interviewees pointed to actual use situations where it benefits the sales presentations, several times during the interview. This positive narrative around the use of immersive VEs seemed to originate from a general view of the AEC industry is highly innovative: *“That’s the premise of the industry, that we try something out [a new technology like immersive VEs] on one project, and for the next project it’s going to be even more wild [introducing a new technology, like head mounted displays, into their daily work routines]”*. However, uncertainty on how to use the immersive VE was also mentioned: *“We had placed the Oculus Setup [the head mounted display] in our atrium [for everyone to use]. Now we have moved it. I think it could be because, everybody could see the person using it. A lot of people didn’t use it [it wasn’t used as frequently as they expected]”*.

The immersive VE’s flexibility was a cause of confusion. However, the confusion was evened out by the immersive capabilities of the VE that make customers feel as if they are physically present. In addition, a general narrative that dictates a positive attitude towards new technologies, encouraged them

to keep using the immersive VE. Overall, immersive VE contributed to a better and thus more stable sales routine.

5.2 Immersive VE in a Nordic General Contractor

A Nordic general contractor operates in most parts of Northern Europe, covers all the phases of a construction project. Since 2010 they have been sketching and designing building models through the use of various CAD software. They are using 3D models as well. The last 3 years they have tried to incorporate more immersive VEs, like head mounted displays, into their sales routine. While the management sees the use of head mounted displays as a good idea the actual use is limited because of technical reasons. For example, when the interviewees tried to demonstrate how they use head mounted display during the sales presentation, the head mounted display couldn't load the 3D model of the building due to a slow WI-FI connection. Therefore, it took some tries to get it to load the 3D model, which prompted the following reaction from the interviewee: *"This is exactly what can destroy progress. If it doesn't work people won't use it. And if you need specialists to use the head mounted display or to help others use it, then it becomes too costly"*. The immersive VE has to be easy to use and work in many different contexts as an interviewee explained: *"We really want to succeed with VR. We want to [the interviewees], the management wants to. And it probably will succeed. But there is a huge change process in this. To make people use it."* The technical issues of the immersive VE as well as the inflexibility of the artefact, made it difficult to integrate them in the sales routine. Consequently the immersive VE led to an unstable sales routine.

5.3 Immersive VE in an Architect Company

An architect company, located in Denmark, is involved in the ideation, sketching and design phase of a building project. Traditionally, they had been using paper and pen, 2D CAD drawings and a normal screen to show potential customers the building designs. Similar to the two general contractors, they started to use head mounted displays in 2015 as well as using 3D models to visualize early sketches of buildings during their sale routines. At the architect company the use of immersive VEs during the sales routine has been less successful. Specifically, they could not integrate into the sales routines because the immersive VE was too flexible, creating doubts on how to use it and hence whether or not it should be used as a part of the sales at all. As a senior architect, in charge of their immersive VR initiative, explained: *"...right now, it is [the immersive VE] more a toy that's not part of any routines"*. One reason was that the head mounted displays used during sales meetings were simply too hard to use: *"We have experimented with different types of software and tried to figure out how to use VR. I can sense some reluctance to use VR"*. Because of uncertainty on how to use the head mounted displays, doubts were raised, which in turn made people reluctant to incorporate the immersive VR into sales. This resulted in a general doubt of the use of immersive VEs. This doubt or uncertainty recurred several times during the interview. For example, the interviewee initially described the benefits of using immersive VEs during sales presentations. However, in the next sentence the interviewee expresses the following doubt: *"The big problem is that when people are using VR they are on their own and you lose them. You cannot talk to them. You do not see what they see, and it's hard to guide the user [the customer that uses the head mounted display]. This is a problem: how do you use VR when presenting it? Because it also breaks the flow when presenting a project [to a customer]."* Thus, a general doubt about the technology was raised – despite the benefits experienced during the actual performance. For the architect company, the flexibility of the artefact has resulted in low use, despite it bringing benefits to the sales routine.

5.4 Immersive VE in a Product Development Company

A product development company that develop ideas into products and subsequently market and sell them for other companies. To build these virtual products, they utilize various forms of 3D CAD software. Since 2014 they have used head mounted displays to sell virtual prototypes of future products to

their customers to make the sales routine more convincing. In 2014, when they first introduced the immersive VE in sales many issues arose, as the interviewee put it: “Two or three years ago this [the head mounted display] was ‘voodoo’. People [customers] didn’t know how to comprehend VR” referring to a general unfamiliarity on how to handle and use head mounted displays. In short, the flexibility of the head mounted display was, in this case, not beneficial, and, the head mounted display allowed for too many types of behaviours. However, how employees and customers should use the head mounted displays during sales meetings was quickly aligned. For example, they observed that senior customers felt unsecure wearing a head mounted display, due to lack of eye contact with others in the room. The company initially experimented with the immersive VE, but at some point, decided to allow for only certain types of behaviours for the customer which had a positive influence on the customer reaction when using the head mounted display, and thus on the use frequency of the immersive VE. A general narrative on the benefits of using the immersive VE during sales was clearly described by the interviewee. Specifically, that the immersive VE is integrated in sales because it helps to immerse the user in the product which in turn helps to make higher quality products. The interviewee explained: “We do not use VR [immersive VEs] to sell more [not the main driver], but to make better products”. A general narrative is clearly defined, which is reflected in the actual use as well. The transformation of a flexible immersive VEs where the use was vaguely defined to defining a specific type of behaviour for the immersive VE was very beneficial. As a result, the immersive VE has been successfully integrated into the sales routine and stabilized it.

6 The Influence of Immersive VEs on Organizational Routines

Using theoretical insights from organizational routines, we depicted four vignettes describing different use of VEs by organizations. We identify two dimensions to explain how the introduction of immersive VEs influence sales routines and hence the use of immersive VEs. The first dimension is **artefact specificity**. Artefact refers to the immersive VEs and the other artefacts necessary for VEs use (i.e. the computer, controllers, CAD-software, instructions). The specificity of an artefact is defined as the degree to which any given artefact specifies user behaviour. For example, in relation immersive VEs, the specificity is the degree to which the head mounted display, the software, the computer, or other devices “dictates” certain user behaviour. If the specificity of the immersive VE is low, then it allows user to engage in a variety of behaviours it is flexible. In contrast, if the immersive VEs specificity is high, then it is an inflexible artefact, and it only allows for certain behaviours. Inflexibility can be positive, if an organization aims for efficiency and productivity, exemplified by the product development company. On the other hand, too much flexibility can also be confusing for users. Thus, whether or not low or high specificity of an artefact is beneficial for organizational routines is context dependent (Pentland and Feldman, 2005). The second dimension, refers to the **divergence of the ostensive and the performative** aspects of a routine. As described in the literature, a routine consists of an ostensive aspect, the general narrative of a sales routine, and a performative part which refers to the actual performances of a routine. If divergence is low between the narrative of a routine and how it is performed it can lead to a stable and effective routines or to inertia. If divergence is high it can on the other hand lead to beneficial change or too much uncertainty around a routine and how it should be performed. Thus, as with artefact specificity, whether or not low divergence (a stable routine) or high divergence (unstable routines) are beneficial for the organization, is very much depends on the context. However, the performative and ostensive aspects are also influenced by the immersive VEs, and vice versa, as will be illustrated in the following.

Specifically, by combining these two dimensions, artefact specificity and routine divergence, it can be argued that the use of immersive VEs is influenced by the specificity of the immersive VEs and the degree to which the ostensive and performative aspects of routines diverge, and vice versa (Table 1).

The four vignettes illustrate how these dimensions affects the use of immersive VEs. Organizations that have low specificity artefacts can increase but also hinder use. Low specificity can lead to flexible artefacts which in turn can create doubts and lead to too much divergence between actual use (performances) and the general narrative (ostensive) of using the immersive VE in a routine.

		<u>Artefact Specificity</u>	
		Low Specificity	High Specificity
Ostensive-performative	<u>Routine Divergence</u>		
	High Divergence	Unstable routine	Unstable routine
	Low Divergence	Stable routine	Stable routine

Table 1: A categorization showing how artefact specificity and routine divergence influence the use of immersive VEs

This flexibility can also increase use as it can allow for experimentation with the immersive VE, which, to some degree, is necessary for artefacts to have if they are to be used in organizations. However if low specificity is to be beneficial, this has to be reflected in the actual performances and ostensive narrative as well and the divergence should between the two, should be kept to a minimum. That is, the users of the immersive VEs should accept that many types of behaviours are allowed, which may or may not be fruitful for the routine. This should also be reflected in the general narrative of the routines by communicating clearly that experimentation is allowed. Just as low specificity (flexible) artefacts can hinder or increase use, so can high specificity artefacts (inflexible artefacts). High specificity artefacts can hinder use if it cannot adapt to the context of the organization. For example by breaking down as happened during the interview with the Nordic General Contractor. This can in turn lead to an unstable routine, if there is a general expectation, that is set by the users and/or management (ostensive), that it should work without any issues, but it keeps breaking down during actual use (performances), too much divergence between the ostensive and performative aspects of a routine will arise. On the other hand, inflexibility can also lead to a stable routine. However, this requires that the divergence between the actual use and the general narrative of the routine is kept to a minimum. Specifically, the actual use of the artefact should be aligned with the general narrative of the routine in which it used, as exemplified during the interview by the product development company.

While the above aims at a theoretical contribution, this categorization contributes to practice as well. In particular, organizational routines is very much a practice oriented theory in contrast much of the current theory that is often derived through surveys or in experimental setups (Orlikowski and Feldman, 2011). Because organizational routines need to be examined in the context in which they are performed, the findings will not be a detached from the context which in turn can lead to more context specific guidelines that can increase the chance of creating change in practice.

7 Conclusion, Limitations, and Future plans

While IS literature has shed much light on the use of immersive VEs, current research has been focusing too much on the individual and applied methods, that are far from practice. Building on interviews from four different organizations and the theory of organizational routines a categorization was developed, aiming at understanding of the various influences of artefact specificity and routine divergence on the use of immersive VEs. As mentioned, this paper presents data from the first of two research phases of this study. The interviews are primarily looking into the *ostensive* narratives of the routines, and as such we cannot observe the actual performances of actors and artefacts (Pentland and Feldman, 2008). We are currently conducting a longitudinal field work to better understand and refine the conceptual model and develop generalizable results.

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