‘Degrees of Freedom’ (DOF) - rendering of virtual characters

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ABSTRACT
The study directs its focal interest towards rendering processes of virtual characters. Hence, it bids to disclose ways in which different forms of embodied actions and behaviours in virtual reality (VR) are part of spatiality as well as of artifacts. Pinpointing the alliance between generic virtual characters, artifacts and virtual environments yield additional understanding of how these phenomena mutually feed off from- and are discerned in light of each other.

Keywords
Rendering processes, embodiment, virtual characters, spatiality, artifacts

INTRODUCTION
“The more [man] tries to deal with things by means of mathematics, however, the more he himself becomes a mathematical given in space and time” (Kracauer 1995:70).

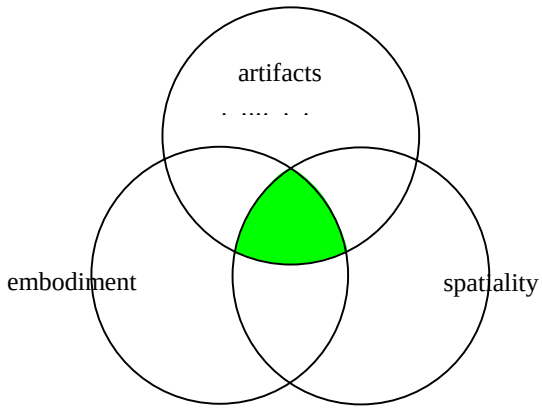
Before embarking on this journey, the reader is encouraged to pause and ponder the comprising title; “*Degrees of Freedom”*. Employed in the study, the words constitute a conundrum encompassing an ambiguous twist. Originally adopted in robotics to depict the minimum of numbers of coordinates required in order to sufficiently specify the motion of a mechanical system (Mataric 2007:39) – that is; the information required in order to recognize- and tell one part of the body apart from the other – the study seeks to augment the term. Henceforth, suggesting “degrees of freedom” to disclose the animation processes of virtual characters as ordered and enacted within- and according to certain social principles, the study also promotes rendering of virtual characters as an undertaking conducted in constant dialogues with restricting as well as enabling structures. By this means, rendering processes of virtual characters are moulded in accordance with physical constraints at the same time as technology-based cultures provide opportunities to acquire new understandings of spatiality (McDougal 2005:77).

EMBODIMENT
The body – and particularly the female body – has been a frequently discussed phenomenon throughout history (Butler 1993; Grosz 1994; Merleau-Ponty 2002). In the era of computerization, Internet, avatars and virtual environments, the discussions are further augmented to – apart from the body – concern how meanings, communities and identities are created and manifested online and in relation to so called new technologies (Hayles 1999; Fornäs et al. 2002; Ihde 2002). Cybercultural studies present the researcher for new challenges; virtual environments constitute seemingly diverse fields from what is referred to as reality, yet they bear resemblances with the life of everyday, which requires "a renewed crossing of communicative and cultural perspectives" (Fornäs et al. 2002:2). *This paper stresses the defying borders of virtuality to open up for novel ways of conveying bodies.* Simultaneously, rendering of virtual characters can serve to yield novel understanding regarding the embodied relation with spatiality. As space can be conveyed and interpreted only as something to be crossed, routed and traversed, it is also intelligible merely in close intermingling with movements (Smelik 2008:145). Henceforth, embodied movements are acknowledged to make space visible. Studies of virtual environments allow for scrutiny of additional possibilities to create connections between spaces (Jacucci & Wagner 2005:191). Coupled with feminist theories, this approach proves useful in re-creations and re-experiences of different aspects of spatiality. Feminist theories also pinpoint alternative ways of enacting embodied expressions; by thinking through the body (Braidotti 2002:5), physical appearances are discerned as multiple and disparate. Rather than advocating thoughts and practices to take place outside the body, feminist theorists correspondingly employ the body and promote thinking through the body, in its full complexity and political significance (Paasonen 2002:202).

THE OBJECTIVES OF THE STUDY
Recent studies of virtual avatars and personal on-line characters (Sundén 2002; Svenningsson 2002; Ladendorf 2002) present an ambiguous picture of gender and bodies as enacted in a variety of ways. Taking posture from the field of cybercultural studies, I seek to – rather than disclosing avatars or virtual extensions of the own person – focus on rendering and manifestation of generic virtual characters such as individuals in crowds, pedestrians, traffickers and visitors in museums or in shopping malls. Often these characters are used more in terms of artifacts

than as living beings in that they play a minor role (Ulicny & Thalmann 2002:28); simply serving to enhance the visitor's experience of an historical place or event. As stated; the area of interest for this study especially concerns rendering of embodiment[1] in conjunction with non-specific characters in these virtual settings. Further it seeks to disclose how bodies are enacted and negotiated in collaboration with artifacts as well as with spatiality; a three-fold alliance that appears to be somewhat neglected. Even though traditional discussions of bodies have been accompanied by studies concerning the embodied alliance with new technologies (Perkins 1993; Dant 1999; Michael 2006) they do not depict embodied collaborations with spatiality; the body is thus implicitly assumed to operate rather detached from spatial surroundings, at best collaborating with artifacts. Consequently, even if embodiment is the common way in which we encounter physical and social reality (Dourish 2004:100) I regard thorough investigations of spatial collaborations with embodiment to be somewhat absent in the field of cybercultural studies.

The virtual body appears as an abstraction in that it turns into a mathematical algorithm (Roberts 2008:50). Independent of its environment, it is thus "disintegrating into 'bits'" (Roberts 2008:46) and divided into detached parts. As stated "[i]deally, the topology of the surfaces [of the human body] should be completely separated from the skeleton" (Thalmann, Magnenat & Thalmann 1990b:139f). Disclosing rendering processes of virtual characters and the ways in which different forms of embodied actions and behaviours are part of spatiality *the all-encompassing aim is thus to disclose how bodies are enacted and negotiated in collaboration with artifacts as well as with spatiality.*

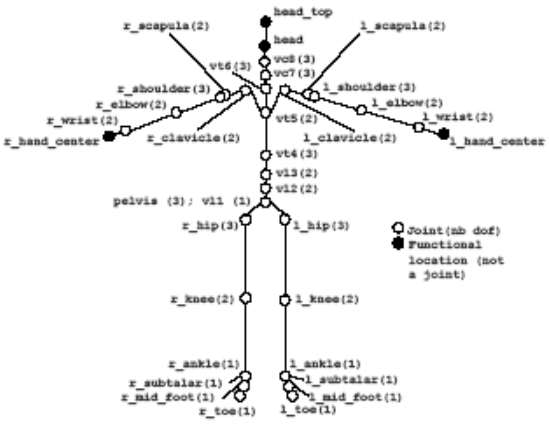


1 This study refers to embodiment as "possessing and acting through a physical manifestation in the world" (Dourish 2004:100). Moreover, embodiment is preferably ...c in that it is a relation between the human and the technologies employed (Inde 2002:137).

METHODOLOGIES

In order to disclose rendering of virtual characters, the study promotes a rather experimental methodological approach, seeking to cover multiple of positions. Feminist ethnographies provide important theoretical- as well as methodological stances; thick descriptions (Geertz 1973:6; Ehn & Löfgren 2001:16ff) of video extracts and animated sequences beneficially disclose embodied collaborations with spatial settings, and pave way for critical scrutiny of the same. Hence, the study offers feminist ethnographic readings of animated video sequences as well as of recorded video extracts. Visualization techniques beneficially serve to map embodied formations and expressions as part and parcel of spatial settings. It is through having bodies that humans experience space (Smyth 2005:250), and the close connection between the properties of environments and the people inhabiting them allows for these environments to shape embodied activities and experiences (Ciolfi & Bannon 2005:219). Digitalization techniques consequently foster novel movements at the same time as crowd modelling activities in virtual environments (Musse et al. 1998:115) endeavour realism and life-likeness.

Scrutiny of virtualization processes and rendering activities discloses a strong connection between embodiment and mathematics; rendering of virtual characters is advocated as a two-sided process in which information and embodiment travel between contexts. As the body turns into codes of information it becomes data made flesh (Hayles 1999:5).



The figure of the body hierarchy set of joints; number of degrees of freedom (Babski &Thalmann 2000:10)

The intimacy between information – in order to direct virtual characters accordingly, mathematical equations and algorithms are employed – and embodiment (Hayles 1999) correspondingly yields novel knowledge when understanding production of bodies. Employing certain number of degrees of freedom, illustrations like the one above depict the result; a standardized (Star 1991) – physically enabled – body that also constitutes the archetype for construction of templates[2]. At this stage it is however a mere *stick figure* (Thalmann Magnenat & Thalmann 1990b:129) or skeleton, deployed and interpreted as a human simply due to lines and the number of degrees of freedom. Noteworthy; as an object for control and mastery (Hayles 1999:5) rather than a symbol for the traditionally born body, the data made flesh also pinpoints information and embodiment as inextricably part of each other. Rather than being born, virtual bodies are constantly being made and re-made (Sundén 2008:160). By discerning body, artifacts and spatiality as closely intermingling, yet as disparate, detachable, optional and instrumentalized, the study stresses the possibilities to yield novel knowledge regarding embodied activities in environmental settings, be they silicon-based or carbon-based. Virtual- and physical settings thus emerge, collide and co-exist (Dix et al. 2005:151).

Augmenting the term “degrees of freedom” (DOF) animation processes of virtual characters are exposed as ordered and enacted within- and according to certain social principles. The particular “degrees of freedom” – enabling as well as restricting – within digitalization processes discloses alternative understandings of the intermingling between bodies, artifacts and spatiality. Rendering of virtual characters is indeed a two-sided process in which information and embodiment travel between contexts. This mutual amalgamation opens up for an understanding of embodiment, artifacts and spatiality as feeding off from each other. Focus on bodies, tools and spatiality as detachable phenomena allow for the researcher to discern how these three phenomena co-exist in tentative – and highly transformable – alliances. Scrutiny of virtualization processes correspondingly discloses a strong connection between embodiment and mathematics; rather than discerning graphs and algorithms in terms of mere mathematical entities – an assumption that most certainly serves to amplify computer systems as entirely the province of technical specialists (MacKenzie 1998:165) –the study pinpoints the need to acknowledge information as embodied. As technologies contain multiple possibilities for use (Ihde 2002:108) virtual environments allow for more diverse ways of enacting presentations (Svenningsson 2002). Bodies, artifacts and spatiality are inextricably part of each other and this is explicit in rendering of virtual characters. Below, the generic virtual body is explicated from three perspectives;

THE INSTRUMENTAL BODY

Drawing on the work of theorist Mark B Hansen (2006); virtual reality is preferably discerned as “a technically trigged experience of the organism’s power of imaging/…/” (Hansen 2006:19) and by this means, I

2 A template can be described as a virtual embodied prototype that is possible to animate and program in a variety of ways.

present virtual environments as relational, negotiated alongside the subjective capability to imagine. Although instrumentalization of the body (Hansen 2006:15) can be said to neglect the same as a living expression, as an active and highly flexible source (Hansen 2006:15) I promote studies of virtual environments as beneficial when discerning embodied spatiality. As virtual reality turns spatial settings into wearable spaces (Hansen 2006:182) the intimacy between embodiment, instruments and spatiality is revealed. Hence, the body is – not re-born (that would be to amplify an assumed human uniqueness) but instrumentalized and thus – re-made or if one wishes; re-designed (Sundén 2008:160; Lykke 2008:13) at the same time as information turns out as highly embodied (Hayles 1999:20). The introductory quote from philosopher Siegfried Kracauer (1995); "[t]he more [man] tries to deal with things by means of mathematics, however, the more he himself becomes a mathematical given in space and time" (Kracauer 1995:70) might – put differently – point both ways. To draw on the work of theorist Katherine Hayles (1999); just as embodiment always is local and specific, information – be it mathematical calculations or graphs – cannot exist apart from embodiment (Hayles 1999:49).

Graphs provide perceptual access, ways of seeing the "natural objects" while at the same time shaping what to see (Roth et al. 2002:328). Transformations of bodies, feelings and characteristics into diagrams and graphic figures – a far from universal construction process – convey them as "detachable instruments"; they are artifactualized and can be moulded and re-shaped according to current preferences. However, the techniques adopted – as stated above are often materialized in graphs, algorithms and scripts – derive from general principles simply applied onto particular instances (Suchman 1987:viii) that may differ immensely. As these approaches favour abstract analytical thinking, human bodies and behaviours are nonetheless – seemingly unnoticed – transformed into- and represented by scripts. Not only do the designers employ a variety of detachable artifacts such as hats, glasses, back packs, umbrellas and shopping bags; the colour of the garments as well as of the skin are also subject to reconstruction and refiguration (Lury 2000:156). Isolating behaviours and body parts from each other as well as from the surrounding environment I consequently claim the body to be represented as a detachable instrument and by this means, it is treated as available for modification in the same way as any other artifact (Dant 1999:187).

The virtual characters are coordinated through the virtual environment – and also gathered together – with help from rather simple directions; avoid collision with each other and pave way from one initial point to the final point through different navigation areas. For the observer, the mass movements nonetheless appear as highly tentative and haphazard. Applying navigable- or walkable areas as well as impassable areas and obstacles onto virtual settings such as streets, shopping malls, amusement parks or green fields, the environments appear to be just as detachable and optional as body shapes and artifacts. Put differently; the environment seems to be eligible. The characters inhabiting the different spatial settings do so rather unaffected by its particularity. Instead, instruments are employed in order to render spatial differences. Quite paradoxically I suggest this disconnection to pinpoint the inextricable relation between embodiment, artifacts and spatiality. Following Katherine Hayles (1999) I stress that central to the construction of virtual characters are – what Hayles (1999) refers to as – informational pathways that connect the body to prosthetic extensions; be they spatial or instrumental (Hayles 1999:2). Henceforth, *studying rendering processes of virtual environments as well as animated video sequences and written material allows the researcher to discern these informational pathways – to my knowledge seemingly difficult to interpret in carbon-based realities – as embodied and also as optional.*

THE FLEXIBLE BODY

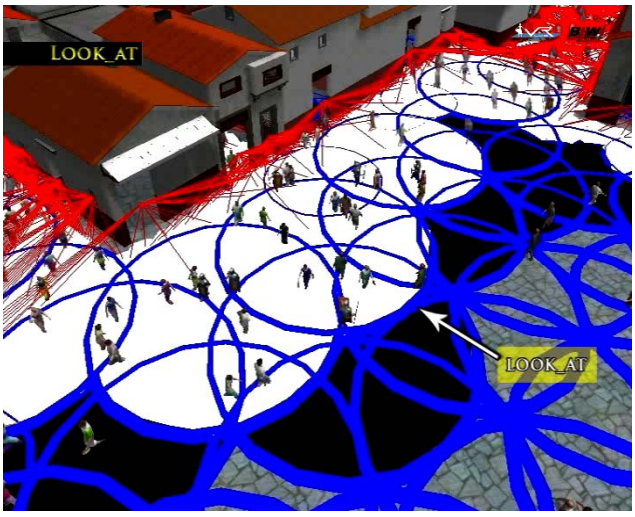
Behaviours and reactions of the virtual characters imitate what is considered as real life; the use of smaller cells or finer grids increases the virtual characters "ability to interact gracefully" (Suchman 1987:12) in order to avoid collision and this in turn enhances the experience of realism. These computer-modelled human motions obviously adopt human movements situated in carbon-based realities as points of departure (Thalmann Magnenat & Thalmann 1990b:135); however, as Fornäs et al. (2002) state; "[v]irtual reality is not actual reality, though it is pretty much alike it, standing in for some absent real world" (Fornäs et al. 2002:29). The flexible body – viewed as a set of joints – can thus be seen as reflecting the cultural understanding of reality as it attempts to behave and react as if it inhabited real life. As stated; "the [virtual] agents from the same group walk together. We considered it as an important characteristic of our model, because in real life people walk in groups" (Musse & Thalmann 2001, my comment within square brackets). In real life people walk in groups (Kracauer 1995:142-170) but they also – I stress – pursue this undertaking according to certain orders. Rendering processes of embodied interaction with surrounding actors and virtual artifacts are thus preferably seen as attempts to mirror a situated understanding of these manifests.

Being directed according to mathematical calculations, swarms of bodies – at least at first sight – tend to interact in seemingly emergent systems. But further scrutiny of movements and behaviors reveals similar patterns; the adaptable body turns into a piece of an organized mass movement as flexibility – the embodied ways of carrying a piece of bread, an umbrella or avoiding collision with other

characters – ironically is arranged according to controlling principles. Even so, the flexible body as made rather than born proves useful when scrutinizing human interaction with artifacts as it explicates naturalized actions in every-day life. Despite – or maybe just because – that the body is conveyed as a detachable instrument, the close intermingling with surrounding materiality is clarified and this allows for further investigations of human-artifact collaboration.

THE SPATIALLY LOCATED BODY

The relationship between spatiality and a subject is often communicated through the body. At the same time as social practices presuppose the use of the body (Lefebvre 1991:40) spatiality works constraining as well as enabling in that it contributes to shape human activities (Ciolfi & Bannon 2005:219f). Simultaneously bodies re-arrange and modify space according to prevalent purposes (Ciolfi & Bannon 2005:219). Following cognitive scientist James E. Hollan et al. (2000) – "in having a body, we are spatially located creatures/…/" (Hollan et al. 2000:190) – the study correspondingly exposes the need for additional research of the intermingling between embodiment and virtual settings. *Spatializing activities* (Hansen 2006:195) are further pivotal as coordinators of the virtual environments. As theorist Mark B Hansen (2006) has it; "the more digitally de-territorialized the architectural frame is, the more central the body becomes as the framer of spatial information/…/" (Hansen 2006:177). By observing how these bodies are manifested and in which ways they occupy space, the de-territorialized environment is thus discerned despite the lack of any spatial evidence.



The body to be digitalized is – as stated above – often encountered as detached from spatial environments, as a mere instrument, seemingly isolated from external forces. Nonetheless, considering the very question "where am I?" strikingly reveals correspondences between the surrounding world and some representation of that world (Hutchins 1995:12). The inquiry discloses reciprocity in that it discerns the "I" as inextricably part of a spatial domain. In order to reply adequately, the researcher needs to establish the correspondence of map and territory, of representation of the environment and the environment itself (Hutchins 1995:13) but also, I claim, a notion of the body as spatially located. As theorist Mark B Hansen stresses; "the body is always a body in space – or better, a spatializing body [and] by necessity an architectural body" (Hansen 2006:183, my comments within square brackets). Further, I acknowledge virtual spaces as wearable in that they are inextricably part of embodied movements (Hansen 2006:182). "[S]pace becomes wearable when embodied affectivity becomes the operator of spacing (Hansen 2006:175). By this means I promote the virtual characters – not only as interacting with the surrounding world (Babski & Thalmann 2000) – but also as an inextricable part of it. Rendering of virtual characters (Caicedo, Monzani & Thalmann 2001:22) correspondingly forces the question "where am I?", which pinpoints human perception of the environment as pivotal (Ulicny & Thalmann 2002:29) when attaining realism.

As computer scientist Paul Dourish (2004) has it; embodied interaction is not non-spatial, non-temporal phantasm; it is something that happens directly in the world (Dourish 2004:153). In order to prove him right I turn towards virtuality, claiming these environments to foster a thriving milieu for scrutiny of embodied collaborations with spatiality. Humans as actually situated in- and moulded by spatial surroundings are – I stress – easier to discern when following the assemblage of virtual characters. As pinpointed; "[in order] to simulate human-like behaviour more closely, we separate the AVA [Autonomous Virtual Agents] from its environment/…/" (Conde & Thalmann 2005:89, my comments within square brackets). Hence, critical investigations of rendering of virtual characters can yield an understanding of how embodiment intermingles with environment.

To recapitulate; technology allows the researcher to discern embodiment, spatiality and artifacts as detachable phenomena; possible to disconnect and assemble in novel ways (Unander Scharin 2008:2). Moreover, in order to convey realism, embodied collaborations with virtual environments are rendered in terms of optional choices, bodies are instrumentalized and spatial settings turn into wearable spaces. Together they form a coalition based on embodied information (Hayles 1999). They intersect and merge in a most capricious pattern. Promoting these phenomena as detachable instruments implicitly calls for them as attachable, optional and mouldable. The production process (Balsamo 1996:78) – of bodies, artifacts or environment – opens up for novel ways of understanding the embodied collaboration with spatiality.

CONCLUDING REMARKS

Augmenting the term "degrees of freedom" (DOF) this paper has sought to disclose animation processes of virtual characters as ordered and enacted within- and according to certain social principles. The particular "degrees of freedom" – enabling as well as restricting – within digitalization processes discloses alternative understandings of the intermingling between bodies, artifacts and spatiality; discerning these phenomena as detachable enables the researcher to explicate the embodied relation with virtual spatiality in terms of electivity and diversity. In addition to this, the intimacy between mathematical equations and embodiment has been explicated. Rendering of virtual characters is indeed a two-sided process in which information and embodiment travel between contexts. This mutual amalgamation opens up for an understanding of embodiment, artifacts and spatiality as feeding off from each other. Focus on bodies, tools and spatiality as detachable phenomena allow for the researcher to discern how these three phenomena co-exist in tentative – and highly transformable – alliances. Scrutiny of virtualization processes correspondingly discloses a strong connection between embodiment and mathematics; rather than discerning graphs and algorithms in terms of mere mathematical entities – an assumption that most certainly serves to amplify computer systems as entirely the province of technical specialists (MacKenzie 1998:165) – this paper has stressed the need to acknowledge information as embodied. By discerning body, artifacts and spatiality as closely intermingling, yet as disparate, detachable, optional and instrumentalized, The paper also stresses the possibilities to yield novel knowledge regarding embodied activities in environmental settings, be they silicon-based or carbon-based. Indeed, this three-fold collaboration allows for scrutiny of extended bodies, artifactual intermingling and spatial domains.

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