Visualizing the Human Form for Simulation and Planning

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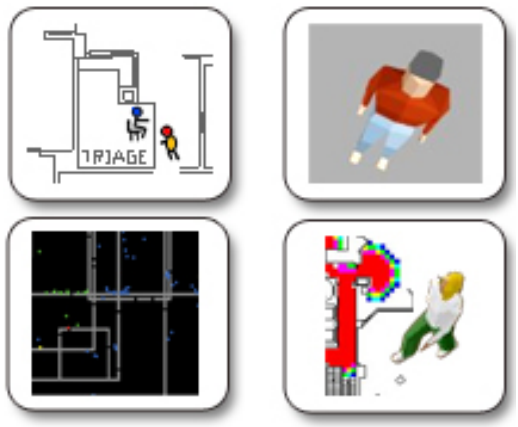

Abstract

In pedestrian simulation, choosing the right visualization for the depiction of a simulated human is important; recent taxonomies of visualization techniques for simulation can aid leverage a wide range of possible choices. Our work is to (1) narrow down these choices to the set of those applicable in pedestrian simulation and (2) give a discussion over possible combinations of these visualization techniques.

Keywords: Pedestrian Visualization, Taxonomies, Design

1 Introduction

Visualization, as part of computer graphics, is driven by two forces: design and science. From the design point of view, one can speak of a visualization as "suitable", "elaborate" etc.; the scientific part, on the other hand, is occupied with the correct mapping of the data onto a graphical representation. A good visualization includes the best of both worlds - it must be estethic as well as purposeful. Recent developments have tried to bring order into the vast field of visualization targeted at simulation by superimposing taxonomies and introducing design rationales to be used. There is, however, still lack of guidelines when it comes to specific problem areas, as it is in our case with the depiction of the human form for pedestrian simulation. This is a pitty, since the simulated human is often the most central object in the simulation.

Our unique contribution to the field of pedestrian simulation is therefore:

- the adaption of standards and design rationales to aid with the depiction of human agents for simulation
- to give a discussion over the suitedness of each choice for different tasks in pedestrian simulation

2 Background

We have based our work on the taxonomic *VDI Standard 3633 Part 11 2003* "Simulation and Visualization", which has been described in detail by [5]. The essence of this taxonomy is to be a common basis for talking about types of visualization for simulation. Of most importance to us is the contained categorization of visualization from a graphical point of view, which we will now describe briefly.

The taxonomy provides eight categories for the classification of visualizations:

- **Dimension**: The number of dimensions used in the visualization. Can be either 1D, 2D, 2.5D or 3D.
- **Representation**: The form which the visualization uses to depict the information that is to be presented. Can be symbolic (using previously agreed symbols that do not have a releationship to the depicted information), iconic (using pictures that convey the meaning of the information they depict) or photo-realistic (a depiction that tries to show the information in a realistic way)
- **Display Format**: The presentational form which the visualization takes.

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Can be either font, table, chart, drawing, picture, virtual world or augmented reality.

- **Scale**: The measure of the geometrical coordinate system used. Can either be linear, logarithmic, exponential or none (in case there is no geometrical reference system for the visualization. Furthermore, it is possible that the axis of the geometrical coordinate system is used to form "categories" or clusters certain ranges.
- **Planar Geometrical Projection**: The transformation of objects in a n-dimensional space to a space of less dimensions. Can be perspective (for foreshortening), orthogonal/oblique(no foreshortening), or none if no projection is needed.
- **Temporal Dimension of Graphical Model**: The definition of the visualization with respect to a time axis. Can be continuous (a visualization which changes constantly), discrete (in steps) or none (if it does not change at all with time).
- **Time Mode within Representation**: In what temporal style the visualization is presented to the viewer. Can be as fixed-image (single picture), non-proportianal full video (some arbitrary frames of video), or proportional full video (frames that are chronologically arranged, and played either in original speed, slower speed or faster speed).
- **Interaction**: The way in which the viewer can influence the visualization. Can be none, navigatable (e.g. start/stop), interaction with graphical model, interaction with simulation model or immersion (three-dimensional walkthrough with possibility to influence graphical model as well simulation model).

In our work, we take the categories of the taxonomy as input, since this will help us decide "what other visualization types would have been possible" for a simulation. Apart from the taxonomy, design science can give a great guidance when it comes to choosing the contents of the visualization, the most prominent contribution being the **standard catalogue of pictograms** referred to as **IsoType** (*International System of Typographic Picture Education,* see **Figure 1** and **Figure 2** left) by Austrian philosopher and educator Otto Neurath [6]. His method was to find images that correspond as closely as possibly to the object they should describe. His work is therefore a catalogue of icons that can be found even today as self-explaining signage as for example the ISO 7001 "public information symbols" signage language [2].

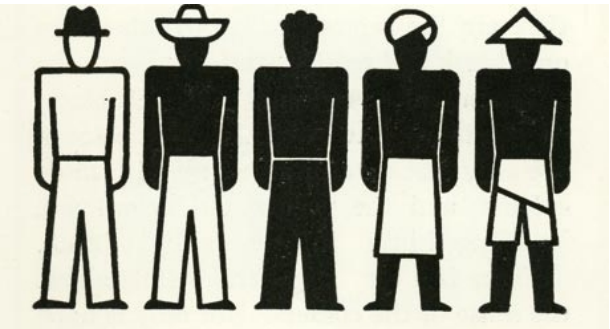

Figure 1: Iconic World Races by Otto Neurath

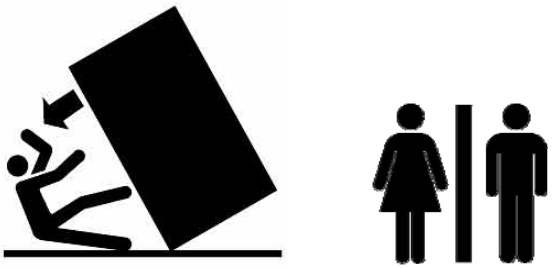

Figure 2: (left) warning sign from [3] (right) toilet sign from DOT symbol catalogue [4]

The nowadays used toilet signs were as well inspired by Neurath, but they are more symbolic than iconic, not showing the act that is actually carried out there but rather a predefined code for it. One norm for such symbolic depictions is the United States Department of Transportation pictogram language [4] which is used extensively and worldwide in the context of travel (airports, train spations, see **Figure 2** right).

3 Elaboration

Our goal, is to "**give a depiction of the form a simulated human**". By depiction, we mean: to generate a graphical view, either in two or three dimensions, of a simulated human in his simulated environment. This can either be a two-dimensional map, an architectural model, or mixture of both. The reason for basing the visualization of the simulated human in his

environment is twofold: First, we argue that process that the simulated human executes cannot be understood without reference to the space where it happens. Second, when the visualization is not anchored to space, the visualization goal likely is not to depict the form of the simulated human, but other statistically relevant variables (e.g. queue length, interarrival time, etc.).

Discussion of the Criteria in the Taxonomy

To begin with, we exclude immediately all criteria that less than 2D, such as: 1D visualization, symbolic representation through characters (e.g.:“bob”), display format font, display format table / spreadsheet as well as display format chart. Furthermore, we ignore all scale criteria (we assume a linear scale), and ignore the interaction criteria as well (our goal is depiction, not interaction). Orthogonal projection, mostly used in modelling but not in simulation, we ignore as well.

We end up with a stripped-down version of the taxonomy, which can be seen in Figure 3. All criteria visible now are applicable to the visualization of pedestrians-

Dependencies between Criteria in the Taxonomy

If all criteria are independent, then visualizations can be switched at will even while the simulation executes. This is, however, not always the case; Figure 5 on page 5 lists a cross matrix of all categories compared for dependency, and clearly shows that there are interdependencies between them. Projection, for example, is strongly dependent on chosen dimension (only 3D geometry needs projection). Display format “virtual world” and “augmented reality” call for dimension 3D, and again projection. Refer to page 5 for the list of dependencies.

Interestingly, the criteria representation, dimension and temporal dimension *are* really independent. Therefore , switching those criteria would be possible. This is tried in Figure 4 through the use of 3D PDF Technology[1]. However, since animations are hard to bring into this format, they were left out.

4 Conclusion

We have adapted a taxonomy for use of visualization in simulation and planning for the context of pedestrian visualization. Not all criteria made sense in this setting, therefore, the taxonomy has been stripped down to encompass only the relevant criteria (see Figure 3).

From an analysis of dependency between the categories of the taxonomy (Figure 5) we have concluded that representation, dimension and temporal dimension are indexpendent, therefore suited for switching.

A sample implementation of such an interactive visualization switching has been tried in Figure 4.

5 References

[1] *Acrobat PDF, 3D Content.* 7th ed.: Adobe.

[2] ISO 7001 *Graphical symbols -- Public information symbols.* 2007th ed.

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[4] U.S. Department of Transportation, *Transportation Pictograms.*

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About the Author

Gabriel Wurzer writes his PhD. on “Process Visualization for Hospitals” with the Institute of Architectural Sciences of the Technical University Vienna, Austria. His background is Computer graphics, Information Visualization as well as Non-Photorealistic Rendering.

dimension	2D	2.5D	3D		
representation	symbolic/abstract	iconic/stylized	iconic/close to reality	photo-realistic	
display format	drawing/diagram	picture	virtual world	augmented reality	
planar geometrical projection	none	oblique	perspective		
temporal dimension of graphical model	discrete	continuous			
time mode within presentation	fixed-image	non-proportional full video	proportional full video / slow motion	proportional full video / real time	proportional full video / fast motion

Figure 3: Relevant Criteria for Depiction of Human Form

Figure 4: Towards interactive, switchable Visualizations

Appendix: Table for Dependence between Categories of Taxonomy

	dimension	representation	display format	projection	temporal dimension	time mode
dimension						
representation	independent					
display format	dependent (1)	dependent (2)				
projection	dependent (3)	independent	dependent (4)			
temporal dimension	independent	independent	independent	independent		
time mode	independent	dependent (5)	dependent (6)	independent	dependent (7)	

Figure 5: Dependence between Categories of Taxonomy

(1) display format "virtual world" and "augmented reality" needs 3D as dimension
(2) display format "drawing" is only compatible with representation "symbolic / abstract" and "iconic / stylized", display "picture" only with "iconic / close-to-reality" and "photorealistic".
(3) projection "none" is only applicable to dimension "2D" and "2.5D", oblique is for "2.5D" and "perspective" for "3D"
(4) projection "none" not applicable for display format "virtual world" and "augmented reality", and projection "oblique" not compatible with "augmented reality"
(5) time mode "fixed image" is maybe impossible with representation "photorealistic"
(6) display format "virtual world" is not compatible with time mode "fixed image"
(7) time mode "fixed image" cannot work with temporal dimension "continuous"