© Nottingham University Press
Proceedings of the International Conference on Computing in Civil and Building Engineering
W Tizani (Editor)

Comparing structure-based and function-based user interfaces for traffic simulation

Timo Hartmann & L. L. olde Scholtenhuis
Construction Engineering and Management Dept, University of Twente, The Netherland

Keywords: structural simulation, functional simulation, human computer interaction, traffic simulation

Simulation tools should not only support the evaluation of ready-made design alternatives, but also the fluid modelling of new alternatives. To do so, simulation tools need to provide user interfaces that allow designers to search the solution space for specific design problems, while they, at the same time, visualize the simulation results of specific alternatives within the solution space. So far, however, we know little about how to design user interfaces that meaningfully allow for this duality of functionality and it is still very cumbersome to use most commercially available simulation programs to quickly model and evaluate different design alternatives. To advance our knowledge in how to design meaningful simulation user interfaces, we present the outcomes of a lab experiment that we conducted with a class of 50 students. We asked the students to generate a traffic scheme for the centre of a mid-sized city in the Netherlands and to evaluate the scheme using a simple traffic simulation model under consideration of the following performance indicators:

- Maximize travel speed,
- Minimize travel distance,
- Minimize travel time, and
- Maximize parking possibilities.

During the experiment, half of the students used a spreadsheet tool that allowed modelling of alternatives and that displayed simulation outcome in a function-based format that helps users to understand the underlying function of the simulation algorithm. The other half of the students used a geographical information system that allowed users to model new alternatives by directly interacting with a street map of the city centre and that overlaid the simulation outcomes on the same street map. We call this type of interface a structure-based interface because it is designed to support users in understanding the structure of the simulated design alternative. The paper compares these two different user interfaces with respect to how many alternatives students were able to generate in a specific time frame and how well those alternatives scored according to the simulation output.

Table 1 summarizes the overall outcome of the experiment with the mean and standard deviations of the number of feasible alternatives the students were able to develop in each of the different software programs and the scores of these alternatives on the performance indicators. An evaluation of the data shows that the participants that used the DigiMap software were on average able to generate more alternatives than the participants that used the Excel spreadsheet. Looking at the indicators, however, it seems as if the means of the developed alternatives on the different indicators does not show much

difference between the participants that used DigiMap and those that used the Excel spreadsheet. Only the indicator 'Extra Travel Distance' shows an apparent difference between the means.

Table 1. Outcomes of the Experiment. Means and standard deviations of generated alternatives and indicator scores in Excel and DigiMap.

	Feasible Alternatives per Participant	Car Speed	Extra Travel Distance	Extra Travel Time	Extra Parking Lot Occupation
DigiMap Mean	1.26	33.00	3.33	105.21	41.21
DigiMap Std.	0.98	4.47	7.47	9.19	7.79
Excel Mean	0.80	32.20	0.50	103.15	46.25
Excel Std.	1	3.12	1.54	5.61	4.66

Next to the little overall difference in the mean values, the difference between the standard deviation of the scores of the different alternatives on the indicators is much higher for the participants that used the DigiMap software. We can analyze this higher standard deviation from two different stand points. On one hand, a higher standard deviation means that participants that used DigiMap on average were able to more broadly evaluate the possible search space of all alternatives. This more broad evaluation then led to scores on the indicators that were significantly higher and to scores that were significantly lower. At the same time, the smaller value in the standard deviation for participants that used the Excel spreadsheet might also mean that the spreadsheet's function-based interface allowed the meeting participants to search the solution space in a more efficient manner. This second argument is further supported by the little difference in the mean of the scores between the two groups of participants.

The above findings suggest that designers should use a balanced visualization approach to support their design solution search with visualization tools. Because of the possibility to quickly generate more alternatives and to, in general, more widely search the space, designers should use a structure-based visualization tool. Our data supports this recommendation, by showing that experiment participants that used the DigiMap software, were in general, able to generate more alternatives that did spread across a larger area of the solution space as was evident by the larger standard deviation of the indicator scores. On the other hand, we suggest that after initial conceptual solution space searches using a structure-based visualization, designers should then switch to a more function-based simulation to continue searching the solution space in a more targeted way to optimize several alternatives that scored well during the initial broad search of the solution space using a structure-based visualization.

Acknowledgements

The experiment would not have been possible without the help of the students of our Bachelor class Methods and Strategies for Facility Design. We would also like to thank Axis Media Group for providing the DigiMap software to conduct this experiment.