The Requirements for and Benefits of Inter-Discipline Collaboration for Displaying Transport Modelling Outputs

A paper by

Sarah Harris
Mott MacDonald

Submitted to the

Transport Planning Society's Bursary Scheme
on a theme of
"Transport Planners and other disciplines – Better together"

1 Introduction

1.1 Background

The capabilities for displaying data are ever improving, and consequently, client expectations for the quality of visual deliverables are rising.

Transport modellers are required to provide a wide range of data, often comparing several modelled scenarios. However, this can be challenging as some modelling software packages are not capable of producing aesthetically pleasing images which can be easily understood by non-modellers including the public.

In order to provide high quality deliverables for our clients, stakeholders and the public, informative, clear and professional-looking images are required. It is essential that these should be easily understood by a reader with no transport modelling knowledge, and perhaps limited knowledge of the local area or scheme being assessed. Due to the vast volume of data produced by a transport model, particularly due to the scale of some of the models now being produced, it can be challenging to display the necessary information in a clear way without inundating the user.

This paper will detail existing and potential visualisation methods and discuss the collaboration required and resulting from these.

1.2 Research Undertaken

The research for this paper involved discussions with experts in various fields. The list of people interviewed or who have inputted into this paper can be found in Appendix B – Acknowledgements.

Two surveys were also created to gather the views of transport modellers and other project disciplines on the current visual quality of transport modelling outputs. One was distributed to transport modellers and the other to non-modelling transport professionals. The survey questions and distribution details are included in Appendix A – Surveys. A total of 28 responses to the transport modellers' survey and 21 responses to the non-transport modellers' survey were analysed.

Other references cited throughout the paper using the symbology *[x]* can be found in Appendix C - References.

1.3 Structure of the Paper

Section 2 of this paper details existing model visualisation methodology for creating static images.

Section 3 outlines the possibilities of interactive deliverables, how collaboration between different disciplines within the project team as well as with clients and third parties is both essential for and can be improved through such tools. Various advantages and disadvantages of the interactive tools will be explored. Sections 4 and 5 will then review the existing and potential interactive capabilities.

Each section discusses situations where transport modellers collaborate with other disciplines, demonstrating that we are indeed "better together".

The Conclusion (Section 6) provides a summary of the points discussed in the main body of the paper and recommends how current ways of working could be improved based on these outcomes.

2 Static Deliverables and the Necessity for GIS

2.1 Standard Deliverables and Modelling software capabilities

For most transport modelling projects, the required deliverables are usually a series of reports as follows:

1. Transport Data Collection Report;
2. Model Validation Report;
3. Forecasting Report; and
4. Economic Appraisal Report.

These all require model outputs to be presented as static images.

Most of the required visual deliverables can be produced within modelling software packages. However, there are some that cannot be due to the following key reasons:

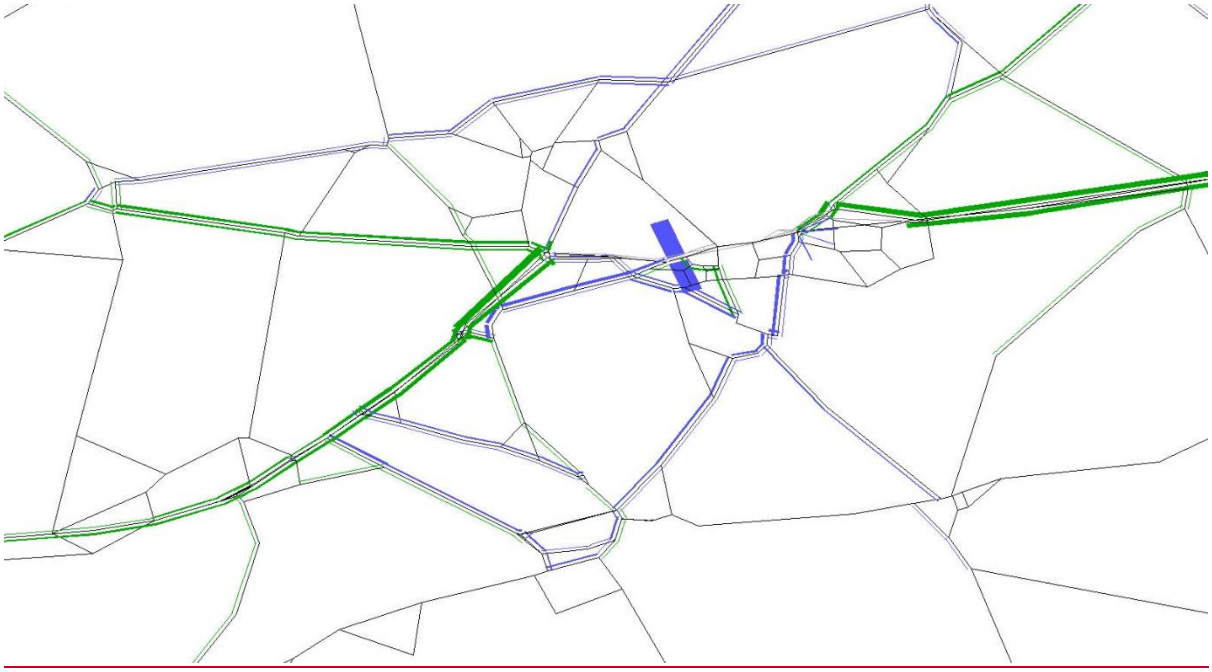
1. SATURN operates using Passenger Car Units as opposed to vehicles, meaning that heavy goods vehicles and cars can be modelled proportionately to length or required junction gap. SATURN is only capable of displaying traffic flows in Passenger Car Units, thus being unintuitive for non-transport modellers and inconsistent with the Department for Transport's Transport Analysis Guidance (TAG) *[1]* in which the units used are vehicles.
2. It is not possible to display data in an amalgamated form. The model validation process, which assesses the quality of the base model against observed data, involves the amalgamation of counts into groups called screenlines and the amalgamation of links into journey time routes in order to assess the model against the TAG criteria.
3. Not all software packages have the capability to display cartographic-based data such as zoning systems or modelled areas.
4. Data manipulation prior to displaying can be difficult. For example, the TAG validation criteria involve a statistic called GEH[1] which requires manipulation of the modelled and observed traffic flows. It is relatively simple to display this in VISUM but is less easy in SATURN.
5. Some economic appraisal and other non-assignment software suites do not have any visual capabilities at all. An example of this is COBALT (Cost and Benefit to Accidents Light Touch), which assesses the collision impacts of a scheme. As such an important assessment, it is vital that visual outputs are displayed in such a way that can be understood by many different people outside of the transport modelling and economics team.

For the deliverables which cannot be produced within the modelling software, the use of Geographic Information System (GIS) software is therefore essential.

Until relatively recently, SATURN was only viewable in its inbuilt viewer P1X, which has no background mapping and in which the links (roads) are drawn as straight lines between the nodes (junctions). An example of this is shown in Figure 1, in which the difference in flows between the without scheme and with scheme scenarios using blue (less traffic with the scheme in place) and green (more traffic with the scheme in place) bandwidths.

[1] The GEH statistic (named after Geoffrey E. Havers) is a standard modelling statistic based on the Chi-squared statistic. See TAG Unit M3.1 *[1]* for more information

Figure 1: SATURN flow difference plot

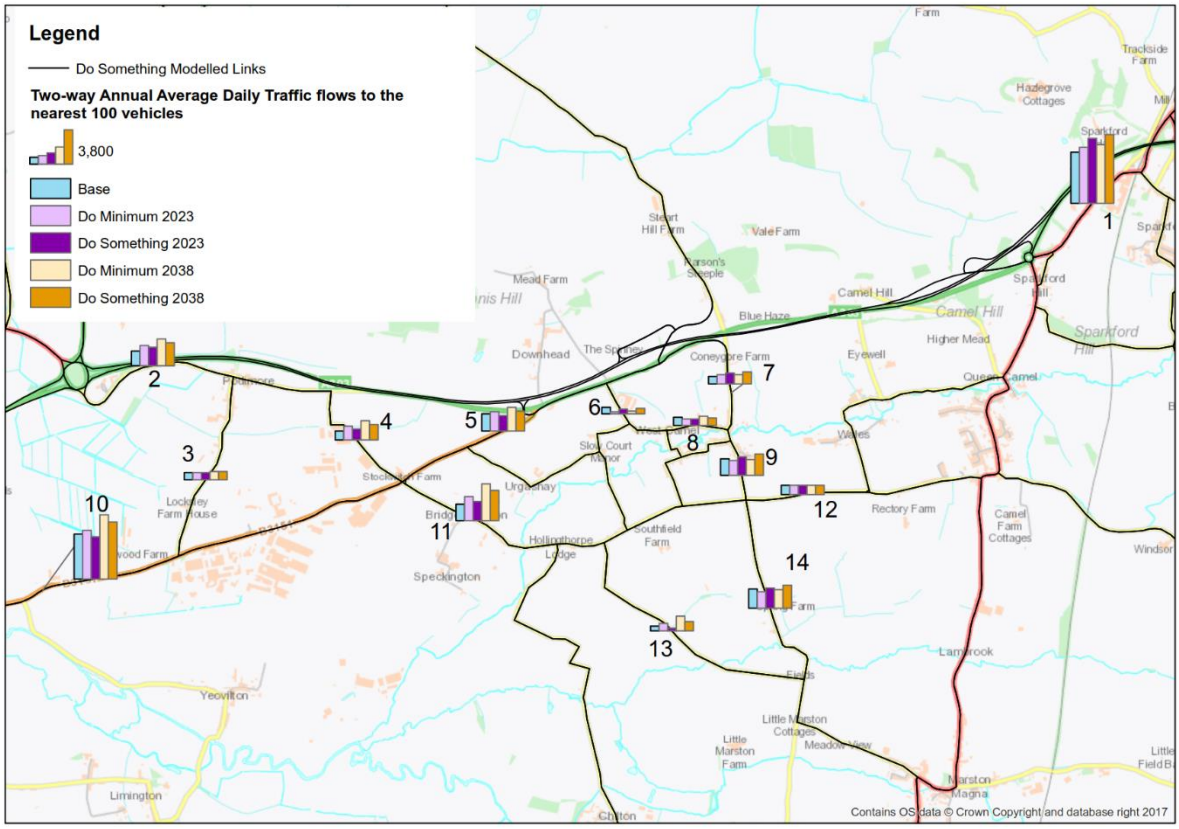


Source: A303 Sparkford to Ilchester Stage 3 Combined Modelling and Appraisal Report *[2]*

In 2013/14, the SATURN team released a new element of the suite called SatView, for which most of the same data types can be displayed as P1X and a map can be loaded in the background. The links can also be bent using SatView, MapInfo or other GIS software such as ArcGIS to follow the route of the actual road. It is possible to export information from SatView into file formats that can be used in GIS software such as MapInfo and ArcGIS. SatView marked a significant improvement in the visual capabilities of the SATURN software suite, but the uptake of it has been low (as mentioned in some survey responses) because the capabilities are still not as developed as GIS software, so many transport modellers still elect to us those instead.

The capabilities of other software suites vary. However, the resultant images are rarely as aesthetically pleasing as those produced using external GIS software such as ArcGIS or MapInfo. Examples of this include plots that compare a number of scenarios. Software such as GIS has the capability to display the information in charts, as shown in Figure 2, which some assignment software packages lack.

Figure 2: Example of using bar charts to display traffic flows using ArcGIS

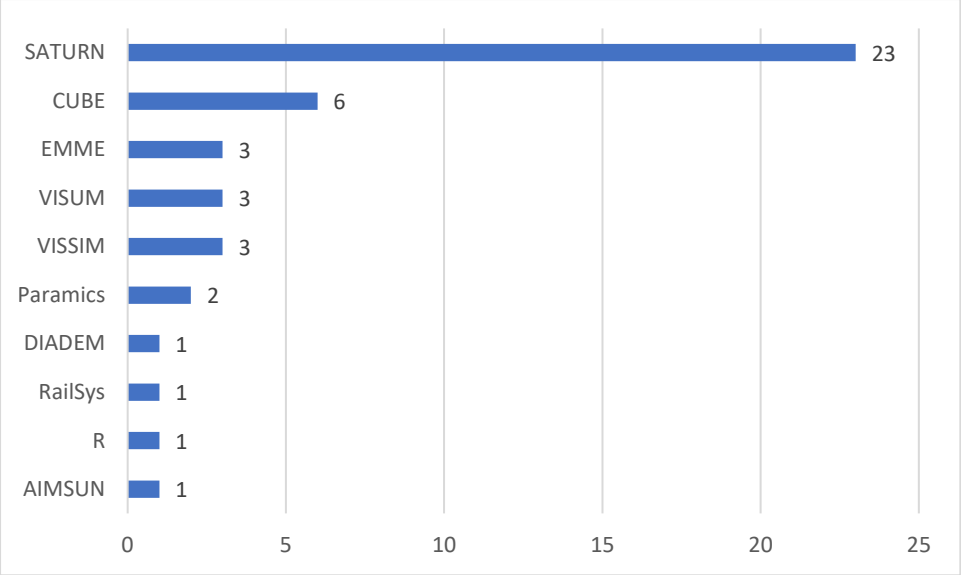


Source: A303 Sparkford to Ilchester Stage 2 Public Consultation Information *[3]*

2.2 Survey Results: Transport Modellers' Views

The participants of the transport modellers' survey were asked which software package(s) they commonly use and the responses are presented in Chart 1. 85% of respondents were SATURN users, demonstrating (subject to the limited validity based on the small sample size) its prevalence in the industry. For this reason, it is often used as an example in this paper.

Chart 1: Number of responses by software package



The survey went on to ask: "How satisfied are you with its [the software's] visual capabilities in terms of producing deliverables?". The results are displayed in Chart 2.

Chart 2: Transport modellers' rating of the software's capability for producing visual deliverables

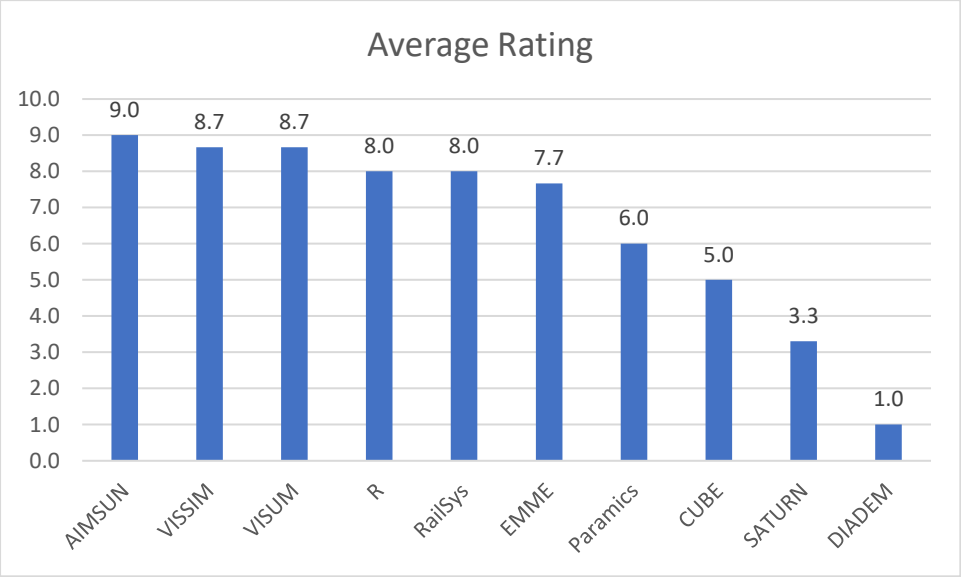
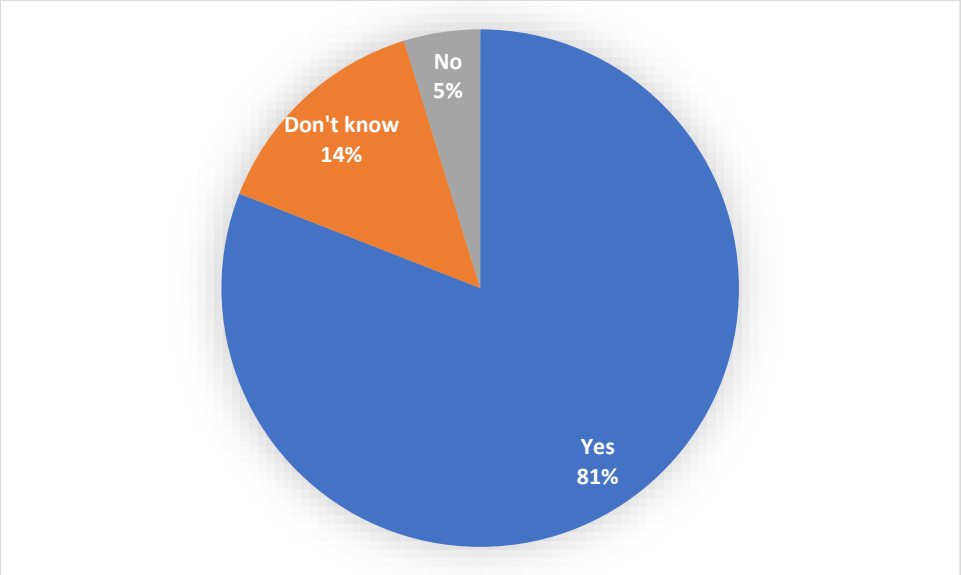


Chart 2 echoes statements made in Section 2.1: SATURN's current capabilities are considered quite poor but the capabilities of other software packages is significantly better. However, with the small sample size, particularly for non-SATURN software packages, firm conclusions cannot be drawn.

2.3 Survey Results: Non-Modelling Transport Professionals' Views

The non-transport modellers' survey also asked about the quality of the transport modelling deliverables produced and whether/how the deliverables should be improved. The average rating of deliverables received was 5.8/10 and the response to whether the quality should be improved is given in Chart 3. 81% of respondents would like to see improvements, and the comments on how they should be improved saw a key theme of features that would help contextualise the transport modelling data relative to the scheme, such as background mapping. Presently, this is best done using GIS software.

Chart 3: The opinion of non-transport modellers on whether the quality of transport modelling visual deliverables should be improved



2.4 Summary

Given the frequency with which GIS software is used to produce plots and given its usefulness throughout modelling projects in terms of having a live mapping database containing information that can be navigated, overlaid, toggled on and off easily, and updated in line with the model updates, the more standard mapping skills should be acquired by modellers themselves.

GIS experts often assist the modelling team by providing training, help and useful files and by undertaking the more complex visual tasks, such as density and heat mapping; creating isochrone catchment areas for journey time and accessibility analysis and spatially analysing economic benefits against demographic data such as areas of income deprivation for use in the Distributional Impact Assessment, which is an element of the economic appraisal of a scheme in which the scheme's economic impacts are analysed based on their effect on certain demographic groups.

This is a key example of an essential inter-discipline collaboration for transport modellers, working together with visualisation experts to produce better deliverables for the benefit of the project team, clients, stakeholders and public.

3 Interactive Visual Tools for Transport Modelling Data

3.1 Overview

Section 2 discussed static deliverables produced as standard for transport modelling projects. Current planning application and scheme examination processes require the reports in this format but there are occasions when interactive visual images are appropriate. This section will discuss the advantages and disadvantages of interactive visual tools, including opinions from the survey respondents.

3.2 Advantages of Interactive Visual Tools

Interactive tools enable transport modelling data to be displayed for the whole model in one location. This is invaluable to any audience who has a particular interest in specific areas of the model, for example local residents at public consultation events or local highway authorities who are carrying out model reviews in their borough. The information they seek may not have been included within the handful of static images included in a report. Being able to display more information in this manner may assure the public that the scheme promoters are being open about the information rather than cherry-picking information that the scheme promoters want them to see.

The ability to toggle data layers on and off and to zoom into an area of the model makes it clearer and easier to understand the data presented whilst also combatting the risk of being overwhelmed with the plethora of information available for the whole model. This is vital for any non-transport modelling audiences, such as in public consultations, presentations to clients or carrying out work alongside other project disciplines.

Additionally, online GIS viewers are key to facilitating collaboration within different disciplines of a project team, as all the information can be stored in one place. For the transport modelling team, this removes the need to keep extracting flows for various modelled areas for the environment team for use in their air quality and noise assessments; for the design team to use in any traffic-dependent design decisions or for third parties or clients. This results in a time efficiency.

3.3 Disadvantages of Interactive Visual Tools

For a transport modelling project, a plethora of information can be stored in GIS format. For source uniqueness purposes and to allow the necessary collaboration between project team disciplines, it is best for data to be stored in one location. However, it is not necessarily the case that all this information could be shared with third parties. For example, landowner information is often a key component of the project but under the General Data Protection Regulation (GDPR) *[4]* legislation, this information cannot be shared beyond the necessary persons. Therefore, caution should be taken when sharing information with third parties, and a separate database of GIS layers should be set up for this purpose.

All transport models contain some degree of uncertainty. If information is presented using an interactive viewer, this means that information could potentially be available for every road and junction in the model. This could cause issues if shared with local residents, employers and members of the public who would take a particular interest in certain locations of the model which may be away from the region of focus and consequently may not be calibrated and validated to as high a

level as some of the key routes and junctions. However, if, given the ability to display data for the whole model in an interactive tool, data were only to be reported for some links and nodes in the network, this may be construed as hiding information. Many people can interpret model results too literally, not understanding the model's uncertainty, inaccuracy and inability to model all possible time periods and scenarios, as, in reality, the behaviour and volume of vehicles on the roads changes every day. This is particularly true of micro-simulation model outputs which depict individual vehicles.

As noted previously, making GIS files available online would provide a high volume of data. This may result in user confusion, the message getting lost or being too complicated for displaying information that could be conveyed in a relatively simple way using a static image.

It may be necessary to restrict certain information to certain third parties in order to avoid the issues mentioned above. This may involve having partitions of the tool, separated by security controls – one for the project team, one for the client or stakeholder and one for the public depending on the required information by each party and the restrictions such as GDPR on what can and cannot (or should and should not) be shared.

The remainder of this section will detail the responses of the survey respondents on this topic.

3.4 Survey Results

3.4.1 Transport Modellers' Survey Results

The transport modellers were asked whether an interactive tool would improve the quality of deliverables produced and if so how. The results are displayed in Chart 4. They were also asked whether an interactive tool would improve collaboration with other project disciplines and/or clients and third parties and if so how. The results are displayed in Chart 5. Neutral answers include where respondents did not answer the question.

Chart 4: Would an interactive tool improve the quality of deliverables?

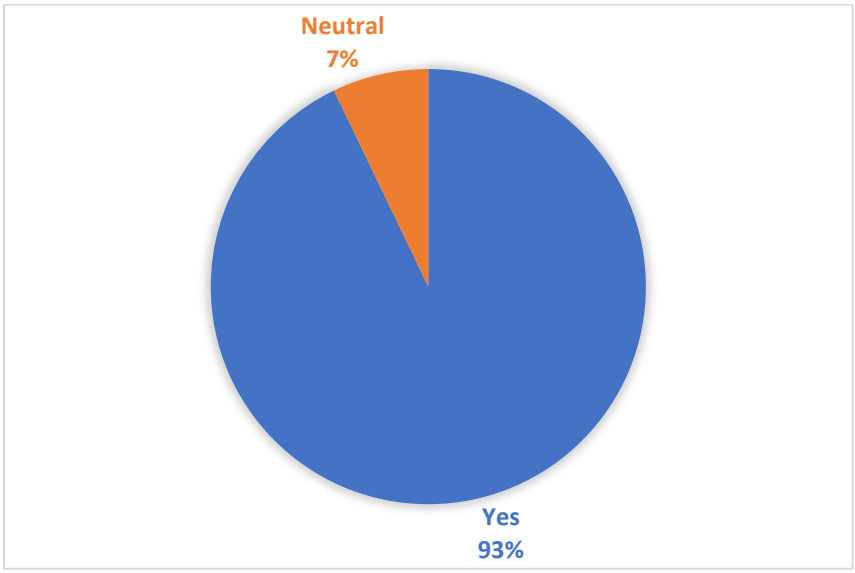
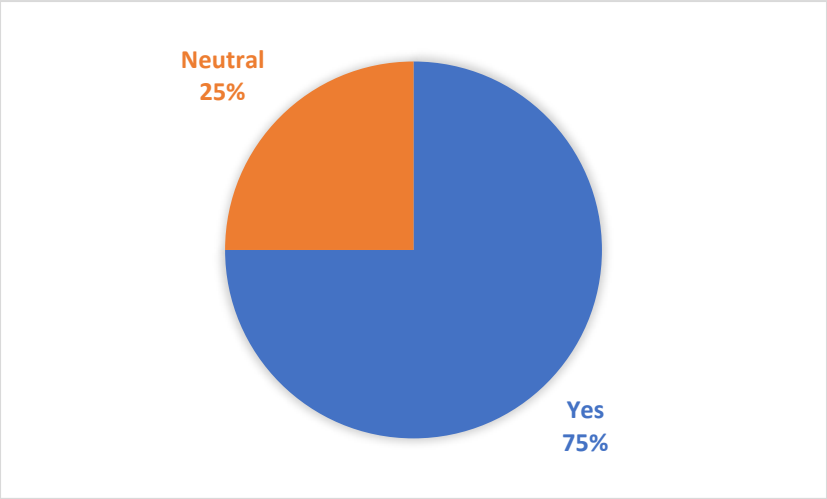


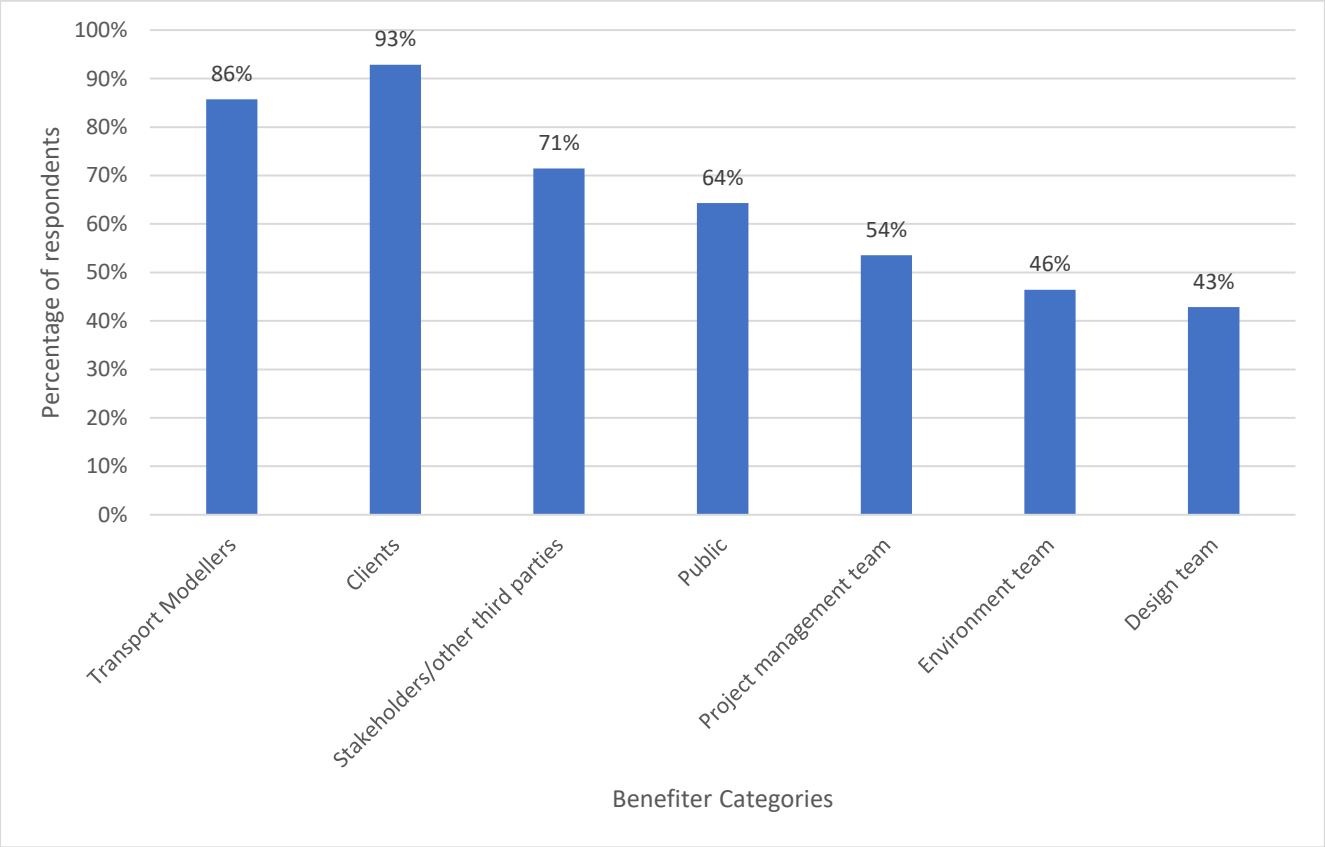
Chart 5: Would an interactive tool improve collaboration?



None of the respondents stated that an interactive tool would not improve the quality of the deliverables or collaboration.

The participants were asked to select which of the listed categories of people would benefit from an interactive visual tool. The results from this question are displayed in Chart 6.

Chart 6: Who would benefit from an interactive visual tool?

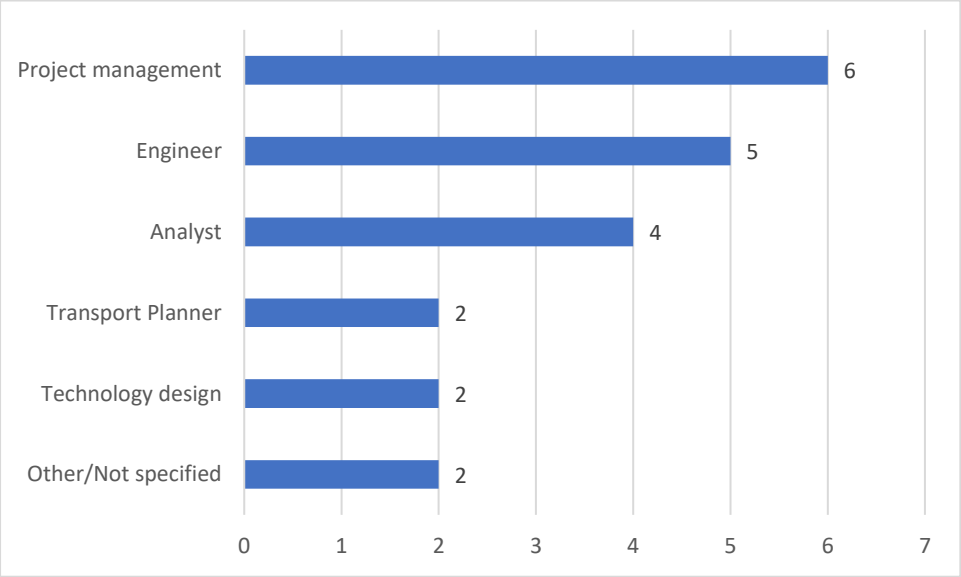


Some key ways in which an interactive visual tool could improve the quality of deliverables and collaboration within and outside of the project team arose from the responses to the "how" parts of these questions and other questions where the respondents were asked to provide comments. The ability for users to view specific locations and scales and the ability for other disciplines to access data quickly and interrogate the results were both common responses to this question.

3.4.2 Non-Transport Modellers' Survey Results

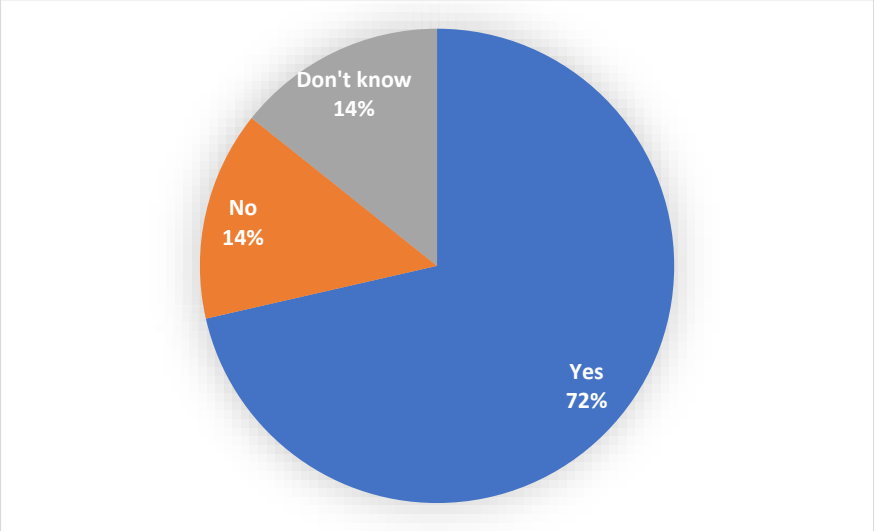
Responses to the non-transport modellers' survey were received from a range of different disciplines, as summarised in Chart 7.

Chart 7: Number of responses by job role category



The participants were asked if they thought an interactive visualisation tool would improve collaboration between transport modellers and their and/or other project disciplines and if so how. The responses are summarised in Chart 8.

Chart 8: Non-transport modellers' responses to whether an interactive visual tool would improve collaboration within a project team



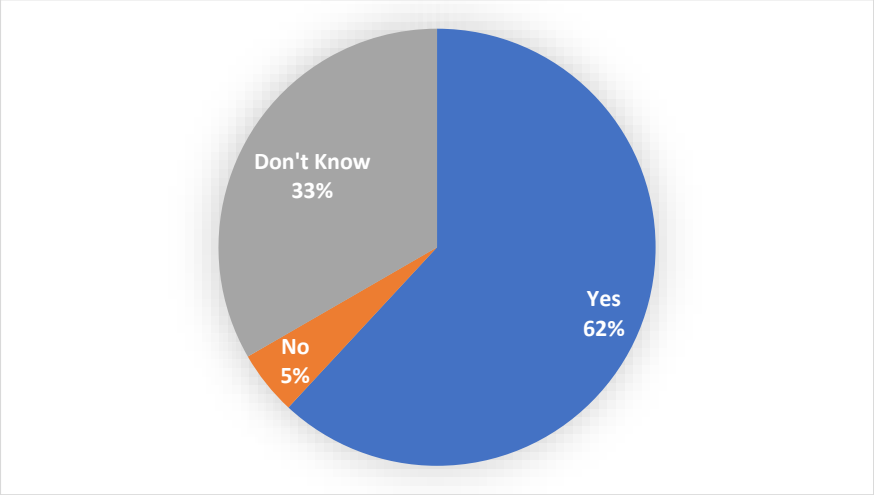
Nearly three-quarters of participants thought that the inter-discipline collaboration would be improved. The "how" part of the question showed similar key themes to the comments from the transport modellers: namely, improved clarity of deliverables and improved efficiency.

There were also a number of comments about how the tool should be in a format that can be used by other disciplines. This supports the comments in Section 5.1 about how functionality within specific software packages is not necessarily the answer, and how an external GIS tool would be ideal, as other disciplines such as design (by conversion from the Computer Aided Design software) and environment would be able to use the same tool, overlaying cross-discipline information to aid understanding of the modelling outputs in context.

Interestingly, although only 43% of respondents in the transport modellers' survey thought that the design team (called engineers here) would benefit from an interactive visual tool for transport modelling outputs, 100% of the respondents in the Engineer category or 86% of respondents in the Engineer and Technology Design categories combined answered Yes to the question shown in Chart 8.

The participants were then asked if they thought that such a tool would improve collaboration with the public or other third parties. The results are summarised in Chart 9.

Chart 9: Non-transport modellers' responses to whether an interactive visual tool would improve collaboration within the public and third parties



This shows a slightly less positive response, mainly due to many respondents having concerns about the public and third parties misinterpreting data or that the data would need to be simplified when sharing with these non-technical users. However, there was still a majority in favour of the tools, for similar reasons as with the inter-project collaboration mentioned above and for use in public consultation, including some positive feedback from where micro-simulation videos had been successfully used in this context.

The key themes that came from the non-modellers' survey comments were:

1. Regarding the engineering requirement for BIM (Building Information Modelling) which involves a higher level of collaboration to produce federated models; and
2. The clarity of transport modelling outputs could be improved with an interactive visual tool, both within and outside of the project team.

3.4.3 Cross-survey Key Messages

Some key messages, shared by the modellers and non-modellers alike were highlighted in the survey responses and are summarised below:

1. Visual capabilities for transport modelling across a variety of software packages should be improved and an interactive visual tool would aid that by increasing clarity of information to non-modellers.
2. An interactive GIS tool would increase efficiency by removing the need to create several plots.
3. Many responses across the two surveys referred to the reputation of transport modelling as a "black box/art". If the rest of the project team do not understand the transport modelling outputs then they will not be able to relay this information to clients, public and other stakeholders successfully. Therefore, increasing the collaboration between transport modellers and other disciplines within a project is fundamental to presenting clear information to the end users.
4. Collaboration both within and outside of the project team would improve with the introduction of interactive visual tools for modelling outputs.

Although both surveys showed majority support for interactive viewers, many comments from the survey highlighted risks and caveats with such tools, as mentioned in Section 3.3.

4 Microsimulation Visual Capabilities

4.1 Overview

Transport modelling can be split into two categories:

1. Strategic models, which are large scale and do not model the interactions between individual vehicles but instead are based on average flows over a period of time; and
2. Micro-simulation which comprises much smaller modelled areas, often just one or a handful of junctions, where interactions between individual vehicles are analysed.

The outputs from these two types of model vary significantly. This section will discuss the existing capabilities for visualising micro-simulation model outputs.

4.2 Videography

Micro-simulation modelling software packages and websites, such as VISSIM and ITO Motion, include the capability of displaying modelled flows in a video format. This enables the viewer to see how the vehicles interact with each other on the network, making it clear how queues build up at junctions. Often vehicles or links are colour coded, for example you can use one colour to denote stationary vehicles, one to denote slow-moving vehicles and one to denote fast-moving vehicles. Part of the reason this works so well for micro-simulation models is that the modelled area is small, often consisting of a small cluster of junctions. This technique does not work so well with a strategic model, which often do not provide time series data modelling individual vehicles but are based on average flows over an hour, with fractional trips possible. However, there are clear advantages of this method such as its aesthetic appeal and understandability to the non-technical user. VISSIM outputs can be exported into mp4 files to be viewed on any standard media player with no license required, meaning that the videos can easily be shared with any intended third party.

From Chart 2, we see that the surveyed transport modellers rated VISSIM highly. Interestingly, the rating of the micro-simulation software packages (VISSIM and Paramics) were not rated significantly higher than some of the strategic software packages. This could be because the higher calibre visualisation tools available for micro-simulation models are often not appropriate for strategic models, as mentioned above, so the visual capabilities of the packages are similarly fit for purpose. With the relatively small sample size, particularly for non-SATURN packages, it is difficult to draw valid conclusions.

4.3 3D and virtual reality

A popular technique for displaying smaller transport planning and transport modelling projects is via 3D design and even virtual reality simulations, which can enable 360° views of a design. VISSIM models can be viewed in this way, allowing people to get 360° views of the traffic situation. These take a considerable amount of time to produce so would only be done at key project stages but have proven very popular with the public in consultation situations. The same encumbrances as with videography prohibit this visualisation technique from being applied to strategic models.

The creation of 3D and virtual reality deliverables requires a 3D CAD expert's input, another discipline with whom transport planners can work alongside to add value to projects and produce professional outputs.

5 Interactive Visual Methods of Displaying Strategic Model Outputs

5.1 Overview

Section 3 of this paper discussed the requirement for an interactive way of visualising model outputs.

Section 4 described some of the capabilities of displaying micro-simulation model outputs and how these would not be applicable to strategic model outputs.

This section of the paper will discuss current and potential interactive visual methods for displaying strategic model outputs and the collaboration involved in this innovative area.

Due to the frequent use of GIS as described in Section 2, many strategic transport models already have an accompanying set of GIS shapefiles. GIS is also frequently used with the majority of other disciplines within a project team, such as for displaying the design on a map background and for mapping environmental constraints. This makes a GIS-based system the obvious choice for enhancing inter-project collaboration. As commented on in the non-modellers' survey, the tool would reach maximum usefulness if it can be a unique tool compatible with the file types used in different disciplines.

However, the GIS software used by transport consultants are often restricted by licenses, meaning they cannot be shared freely with external parties. Therefore, a license-free and free-of-charge option is required, as third parties are unlikely to want to pay.

Online examples of existing license- and charge-free viewers include QGIS *[5]* and Google MyMaps *[6]*, although these also have disadvantages such as maximum file sizes.

Some transport consultants are now creating their own online GIS viewers, which can be shared with the public or stakeholders.

Some modelling software packages already have or are in the process of creating online tools for viewing models without needing a license. The transport modellers' survey asked whether the software they used had interactive visual capabilities. In addition to what has already been discussed in this paper, there were responses regarding

- A cloud-based tool for viewing CUBE, for which login details are required, which is similar to GiGi (discussed in Section 5.3: Case Study 2);
- An interactive R dashboard where people can interrogate simple model results and survey data; and
- The ability to view AIMSUM directly through GIS tools.

SATURN does not yet have such a tool, but the following two case studies detail potential examples of online SATURN-linked GIS viewers.

5.2 Case Study 1: Highways England Regional Transport Models

An example of an online GIS viewer is that being created by Arup for the Highways England Regional Transport Models, a series of five strategic SATURN models covering England which were created for the appraisal of strategic highway projects and corridors of projects. The idea of the viewer is to enable collaboration between the many consultants involved in the maintenance of these models,

with Highways England and with any other third parties with whom it is shared. The viewer contains files showing information such as the flow on all of the modelled links, displayed using bandwidths and with additional information pop-ups when a particular link is clicked. The layers and base maps may be turned on and off as desired. The viewer is still in the early stages of production, with further support from the model promoters required before further investing in its production to reach its maximum potential, but could be a significant step up in the capabilities of sharing SATURN modelled information with clients and third parties.

5.3 Case Study 2: A303 Sparkford to Ilchester

Recently, Mott MacDonald Sweco Joint Venture (MMSJV) presented information such as highway design and environmental constraints and mitigation information to Highways England (the client) in the form of a GIS viewer "GiGi" for the A303 Sparkford to Ilchester scheme. This enabled the client to switch information on and off using a tablet on site, which was very well-received. The MMSJV project manager suggested that presenting traffic modelling outputs in a similar vein would also be a well-received improvement to the portfolio of information on the project, both by the client and by the public during consultation periods.

The current system does not provide open access: login details are required in order to access the information. Selected Highways England staff have this access, but stakeholders and the public do not.

However, GiGi can be embedded in other websites for the public to view. For example, the same GIS system has been used to plot the current roadworks in the county of Cumbria *[7]*. GiGi is embedded in the county council website, where the council staff can update the files and the public can view the interactive map, turn layers on and off and navigate to the locations of interest to them. Given the aforementioned market for interactive information for public consultation, I believe the same method could be applied to a Highways England or other consultation website.

6 Conclusion

For the vast majority of transport modelling projects, the main deliverables are reports, requiring the model outputs to be reported in a series of static images.

Most of the required images for these reports can be created within the software packages themselves. However, to overcome presentational deficiencies, mapping software such as MapInfo or ArcGIS are often used to create informative and aesthetically pleasing plots. For more complex images, this involves transport modellers and GIS experts working together to create better outputs for our clients, stakeholders and the public.

However, there are occasions when more interactive visual methods have their worth, such as during public consultation or for sharing with clients and stakeholders during the course of the project. This paper has discussed methods used to display micro- and macro-model outputs in an interactive way, which enable the user to navigate and view only the information or area of interest to them and to access more data in a manageable way. This collaboration between transport modellers and the clients, public and third parties has the potential to result in fewer challenges and questions during examination periods and ultimately, increased efficiency and success for transport projects.

Such GIS viewers also enable collaboration within the project team, removing the need for repeated model data extraction and in order to understand the local attributes which a particular discipline would not necessarily be aware of otherwise, such as environmental and topographic constraints. This is another example of how transport modellers and other disciplines can increase efficiency by working together.

From the research carried out from this paper, I would strongly recommend that more transport modelling projects utilise interactive capabilities in order to:

1. Improve the quality and clarity of visual deliverables;
2. Increase efficiency of data sharing with colleagues from other disciplines;
3. Enable data for any required part of the model to be displayed in a project context;
4. Integrate better with the other project team disciplines, keeping all visual files in one location, complying with BIM standards; and
5. Improve collaboration and therefore relationships with project team disciplines, clients, stakeholders and the public.

However, there are a number of key things to consider when using interactive tools:

1. Before sharing entire datasets, ensure that none of the data is sensitive to avoid breaching laws on data protection or project confidentiality;
2. Caveat the data explaining the uncertainty and accuracy levels of transport models;
3. Streamline datasets before sharing them to avoid overwhelming and confusing the user; and
4. Consider which information should be restricted to which users.

The implementation of this would both involve and improve collaboration between transport modellers and GIS/visualisation experts, other project team disciplines, clients, stakeholders and the public.

The conclusions drawn above unanimously concur that transport modellers and other disciplines are better together.

7 Appendix A – Surveys

The Transport modellers' survey was shared on the Mott MacDonald intranet's Transport Modelling, Transport Planning and Integrated Transport pages and with many contacts at other organisations including TfL, Arup, Aecom, WSP and Sweco. All recipients were encouraged to forward the survey to any additional contacts who may have an opinion on the topic. A total of 30 responses were received although two responses were excluded due to one being a duplicate of another and one having answers that did not match the questions posed. Therefore, the results analysed were based on the other 28 responses.

The questions posed to the transport modellers were as follows:

1. Name/email (optional)[2]
2. Which assignment modelling software package(s) do you predominantly use?
3. How satisfied are you with its visual capabilities in terms of producing deliverables? (1 star = highly dissatisfied, 10 stars = highly satisfied). If you entered multiple packages in Q2, please rate in the order listed above.
4. What, in your opinion, are the best visualisation features of the software?
5. Do you think the visual capabilities should be improved and if so, what are the key improvements you would like to see?
6. Does your software have interactive visual capabilities (e.g. online GIS tool)? If so, please give a brief description of it.
7. Who do you think would benefit from an interactive visual tool?
8. Do you think that an interactive tool would improve deliverable quality and if so, how/why?
9. Do you think that an interactive tool would improve collaboration between project team disciplines and/or clients/third parties? If so, how?
10. Do you have any further comments on this topic?

The non-transport modellers' survey was also shared on the Mott MacDonald intranet on the Transport Planning, Integrated Transport, Highways, Southampton office and two current Highways project team pages, as well as being distributed to the same list of external contacts as the modellers' survey and additionally to some contacts at Highways England's Transport Planning Group and a Highways England Project Manager. Again, all recipients were encouraged to pass the survey on to any additional contacts who may have an opinion on the topic. A total of 21 responses were received by the deadline which were all analysed. At least three additional responses were later received but as the analysis had already been completed, these responses were discounted.

The questions posed to the non-transport modellers were as follows:

1. What is your job role within a transport project?
2. Which transport modelling software package(s) are you most familiar with? (If unsure, state "Don't know")
3. How satisfied are you with the transport modelling visual deliverables you receive? (1 star = highly dissatisfied, 10 stars = highly satisfied)

[2] Question 1 of the transport modellers' survey was optional and it was stated in the survey description that including contact details meant agreeing to being contacted to further discuss any points raised. This is very similar to Question 10 of the non-transport modellers' survey. All responses were anonymised prior to analysis and reporting.

4. What, in your opinion, are the best visualisation features of the deliverables?
5. Do you think the visual capabilities should be improved and if so, what are the key improvements you would like to see?
6. Does the software package(s) you mentioned in Q2 have interactive visual capabilities (e.g. online GIS tool)? If so, please give a brief description of it. (If unsure, state "Don't know")
7. Do you think that an interactive tool would improve collaboration between transport modellers and your (or other) project team disciplines? If so, how?
8. Do you think that an interactive tool would improve collaboration with the public and/or other third parties? If so, how?
9. Do you have any further comments on this topic?
10. Email address (This field is optional and if you complete it, you agree to me contacting you to discuss any points you have raised further)

8 Appendix B – Acknowledgements

As well as thanking all the survey respondents, I would like to extend many thanks to the following list of people for their co-operation and input into this paper:

- Laura Putt – for being a great mentor throughout the creation of the paper and for all her useful inputs and comments
- Sansaka Sirivadidurage – for providing many useful inputs to the paper and for reviewing my draft paper
- Chris Bruce, Hannah Norman and Joseph McGenn (Arup) – for granting permission to use the Arup online GIS viewer as an example
- Alex Murphy and Elliot Hayes – for granting permission to use the A303 Sparkford to Ilchester scheme as an example
- Sophie Bates - for providing GiGi expertise
- Tim Price and Mike Brodrick – for explaining the TfL visual capabilities and conventions
- Fred Jones – for improving my understanding of VISUM current capabilities
- Michal Sanca – for improving my understanding of VISSIM current capabilities
- Adrian Hewitt and Ed Blake – for providing insight into the online GIS viewers being worked on and those already existing
- Ian Johnston – for providing an insight into TransCAD
- Dan Palmer, Russell Howles and Steve Harris – for proofreading

9 Appendix C - References

[1] TAG Unit M3.1 - https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/427124/webtag-tag-unit-m3-1-highway-assignment-modelling.pdf

[2] A303 Sparkford to Ilchester Stage 3 Combined Modelling and Appraisal Report - https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR010036/TR010036-000240-A303_7.6_CoMMA.pdf

[3] A303 Sparkford to Ilchester Stage 2 Public Consultation Information - https://highwaysengland.citizenspace.com/he/a303-sparkford-to-ilchester-statutory-consultation/supporting_documents/Provisional%20local%20traffic%20information.pdf

[4] GDPR - https://eugdpr.org/

[5] QGIS - https://www.qgis.org/en/site/

[6] Google MyMaps - https://accounts.google.com/signin/v2/identifier?service=mymaps&passive=1209600&continue=https%3A%2F%2Fwww.google.co.uk%2Fmaps%2Fd%2F&followup=https%3A%2F%2Fwww.google.co.uk%2Fmaps%2Fd%2F&flowName=GlifWebSignIn&flowEntry=ServiceLogin

[7] Cumbria council embedded GIS tool - https://www.cumbria.gov.uk/roads-transport/highways-pavements/roads/road-works/newroadworksmap.asp