Transport modelling: is it art or science?

Robert Bain of RBconsult was asked to speak at a recent transport modelling conference and to reflect on the theme; transport modelling – art or science? Intrigued by the question, and to broaden the debate, he polled the subscribers of two active modelling-orientated electronic mailing lists for their views. This paper presents the survey results.

INTRODUCTION

In June 2010 a question was posted to the TMIP mailing list[1] asking subscribers if they thought that transport modelling was art or science. The question drew 98 replies. The same question was posted to the UTSG mailing list[2], generating a further 56 responses. As the TMIP List has 1,319 subscribers, the TMIP poll response rate was 7%. Of the 98 respondents, 30 used the subject line of their email to give their (typically one-word) answers. The remaining 68 (around two-thirds of respondents) provided text in the body of their email to expand on their answers.

The UTSG list has an estimated 1,000 subscribers, giving a poll response rate of 6%. 18 respondents replied by the subject line only. The remaining 38 (as above, around two-thirds) provided expanded answers. For analytical purposes, the responses from both sets of mailing list subscribers were initially kept separate.

THE TMIP RESULTS

The results from the TMIP poll are presented below and are summarised in Figure 1.

Art	34	35%
Science	28	29%
Both	33	34%
Other	3	3%
Total	**98**	

Note: Due to rounding, percentages do not sum to 100%

THE UTSG RESULTS

The UTSG results are presented above and are summarised in Figure 2.

Art	23	41%
Science	13	23%
Both	16	29%
Other	4	7%
Total	**56**	

RESPONSE RATE & QUALITY

It is challenging to find reliable, up-to-date information on the typical response rates for email-based surveys. A Google search revealed rates of 2% - 12%. A large-sample marketing study from the UK, published in 2005[3], reports an average email sur-

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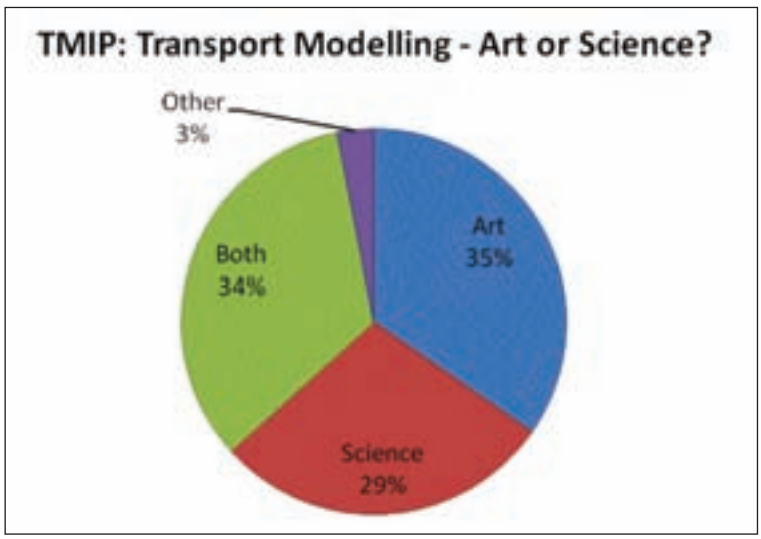

Figure 1: TMIP Poll Responses

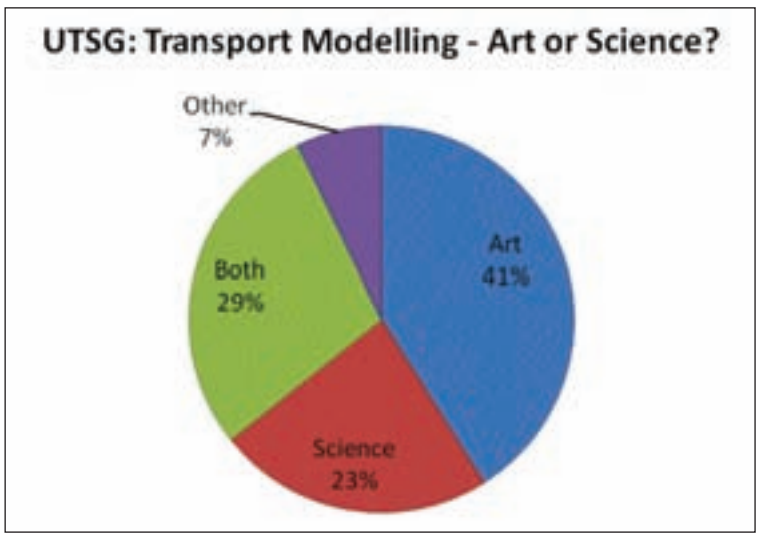

Figure 2: UTSG Poll Responses

	TMIP	UTSG	Combined
Art	35%	41%	37%
Science	29%	23%	27%
Both	34%	29%	32%
Other	3%	7%	5%

Figure 3: For comparison purposes the result are presented individually and in combination.

vey response rate of 11.4%, but cautions that this average was skewed by some marketing campaigns that were 'spectacularly successful'. Notwithstanding, the reponse rates to the surveys described here seem low – given the fact that two active (and focussed) interest communities were being polled.

The low response rates were, however, partially offset by the calibre of the respondents. They included senior staff (managing director, vice president, head of transport modelling) from big-name consultancies in the field, senior representatives (in some cases, the founder/owner) of popular modelling software developers, senior officials from state, regional and local governments, academics (professor, associate professor) from over 20 leading universities and the authors of one of the foremost texts on transport modelling.

COMBINED RESULTS

For comparison purposes the results are presented in Figure 3; individually and in combination.

In all cases, 'Art' is the most popular response, followed by 'Both' and then 'Science'. However 'Art' (at 35%) is very closely followed by 'Both' (at 34%) in the TMIP dataset whereas there is considerably more headroom – wider differentiation – between the two in the UTSG dataset (41% versus 29%).

EXPANDED ANSWERS

The expanded answers displayed no clear distinctions between those provided by TMIP and UTSG list subscribers. Recurring themes quickly emerged.

Justifications for 'Art'

Popular responses included:

- The fact that human behaviour is being studied – and that no unifying theories or proven laws of travel behaviour have emerged (or are likely to);
- The fact that travel behaviour generally – and transport modelling specifically – is open to interpretation based on the viewer's perspective;
- The scope for the application of creative judgment in modelling (designing the data collection, interpreting survey responses, the type of model to use – and how etc.);
- The uncertainty and imprecision associated with modelling and, in particular, with forecasting.

A number of respondents chose 'Art' because they clearly felt that modelling was an art. Others, however, chose 'Art' because of their conviction that modelling was definitely not a science. In that context, respondents pointed to 'scientific method', highlighting issues such as the absence (in modelling) of hypothesis formulation and testing and (mentioned by several) the fact that modelling was not repeatable. Given the same information, different modellers would likely come up with different results.

Justifications for 'Science'

Popular responses included:

- Travel behaviour can be measured – and therefore it can be modelled (hence it is a scientific practice);
- All transport modelling is rooted in evidence and empiricism;
- The fact that modelling involves systematically gathering knowledge, and organising and condensing that knowledge into testable laws and theories (the Artists, on the other hand, disputed this central issue of testable laws and theories).

Acknowledging some of the practical limitations of modelling, some Scientists considered it to be 'science which we have not mastered yet' (or variations on this theme). Some strong anti-Art views were also recorded, for example:

'. . . there are many engineering practitioners who treat it as an Art, perhaps doing the field a disservice in the process . . . It should be clear that this kind of approach is inappropriate and maybe even unethical in the context of massive public infrastructure investments with huge environmental and social impact. It also suggests a hint of marketing or advertising, which is not far off the mark in characterizing those simulation models that are praised more for compelling visualizations than accurate forecasts.'

Justifications for 'Both'

Popular responses included:

- It is scientific art, or artistic science. Art with a scientific foundation (scientific and technical principles);
- The theory is the science; application is the art. Popular variants on this theme included:
  - Model conceptualisation (eg which variables to include) is the art. Building and execution of the model is the science.
  - Modelling is a science but forecasting is an art.
  - Models are the science. Determining how wrong they are is the art!

An interesting analogy suggested by one Bothist was photography. *'You have to have a technical base (ISO, shutter speed, aperture) but you also have to have the art to make a visually pleasing image.'*

In a number of cases, Bothists were keen to provide more detailed insight:

- 25% art, 75% science (several respondents)
- 30% art, 70% science (several respondents)
- 50% art, 50% science
- 80% art, 20% science.

The 'Others'

The Others were a small group. Notwithstanding, some themes emerged – the most dominant of which was to refer to transport modelling as a 'craft' (4 respondents – although one went on to suggest that 'witchcraft' may be most appropriate label). One of the Others suggested 'neither art nor science' – which was challenging to interpret.

EXTENDED ANALYSIS

The TMIP List is more practitioner-based whereas the UTSG List is more academic-based and early responses to the respective polls suggested a possible differentiation of views between practitioners and academics. This supported a theory that practitioners might warm to the notion of their professional activities being science-based (be a Scientist or Bothist) whereas academics might find the concept of modelling being scientific as being problematic (be an Artist).

To test the theory respondents were divided into academics and practitioners; based on their signature block and/or their email address. It was possible to do this for 143 of the 154 respondents.

The responses were then recompiled by academic and practitioner. The results are shown in Figure 4.

There appears to be no evidence to support the theory. The percent-

age of respondents replying 'Art' and 'Science' is almost identical in both groups. The only noticeable difference between the groups is that the academics were much more likely to reply in ways that defied simple classification (Others) than the practitioners.

A QUESTION OF WORDING

This was never intended to be rigorous survey. It was a quick poll to get a flavour of sentiment from individuals actively engaged in the transport modelling profession. Caution should be exercised against reading too much into the numbers (and percentages) presented here – in large part, for reasons explained later.

In truth, the question – although seemingly simply and mildly/very interesting (depending on your perspective) – is a poor one from a survey design point of view. There are two immediate problems. There may be others.

a) When commenting on science, both Scientists and Bothists referred to activities that they described as 'scientific practice': collecting and analysing data; defining and conducting surveys; making various measurements; specifying, constructing and validating models – and so forth. The Scientists and Bothists undertook such activities and, for them, this justified at least some acknowledgement that what they did was science (or part-science).

The Artists, on the other hand, described science more in terms of the natural sciences, laws of behaviour and/or scientific method – and transport modelling clearly troubled them in that particular context.

So the answer to the question; is transport modelling art or science – appears to be critically influenced by what the respondent actually understands to be 'science'.

b) Although a number of respondents had no problem replying 'both' to the survey (49 in total) the question was phrased to prompt – and, in part, constrain – people to reply 'art' or 'science'. Only two respondents (out of 154) complained that a 'both' option was not provided[4]. Nevertheless, it was decided to explore this issue further.

48 respondents replied by simply typing 'art' or 'science' in the subject line of their reply emails. An email was sent back to each of these respondents suggesting that there were four possible answers ('art', 'science', 'both' or 'other – please specify') and asking them if – given these options – they would change their original response. Of the 39 that replied, 28 (over 70%) immediately changed their response; 26 to 'both', 2 to 'other'. The revised results are presented in Figure 5.

The extent of the revised response suggests that 'both' not 'art' was the most popular answer to the poll – by some margin! The follow-up had been conducted with only a sample of respondents. Had others been resurveyed, there is every indication that more people would have opted for the 'both' option.

COMMENTARY

Setting the art versus science issue to one side, few would deny that the challenges for those involved in understanding, modelling and/or predicting travel behaviour are considerable. The modelling community continues to respond through new, improved and increasingly powerful analytical techniques – often accompanied by near-incomprehensible mathematical sophistication. Yet it is important to remember that the quality of data analysis depends on the quality of the data to be analysed. It is easy to assume, for example, that the survey questions frequently asked about travel, preferences and opinions are the same as those that respondents answer – and that all respondents answer the same question.

That was demonstrably not the case here. The responses to a seemingly innocuous, simple six-word question were guided – part-dictated – by the answer set and how it was presented to respondents, and through people interpreting everyday words in different ways. For this reason (among many others) it is perhaps important that basic standards of scientific scepticism are employed when developing and applying transport models, and interpreting their results.

Art or science? Some interesting views were expressed and 'both' emerged as the clear winner. The author is very grateful to all who took time to respond to the polls and, in particular, to those respondents who provided additional information. Does it matter? That's for you to decide.

	Academic		Practitioner	
Art	15	35%	36	36%
Science	11	26%	28	28%
Both	11	26%	35	35%
Other	6	14%	1	1%
Total	**43**		**100**	

Figure 4: The responses compiled by academic and practitioner.

Notes and References

1. The TMIP mailing list is a discussion list for the Transport Model Improvement Program (TMIP). The TMIP initiative is jointly funded/supported by the Federal Highway Administration, the Federal Transit Administration, the Office of the Secretary of Transportation and the Environmental Protection Agency in the United States. Although membership is open to individuals in other countries, the mailing list maintains a strong US focus.

2. The UTSG mailing list was set up by the Universities Transport Study Group (UTSG). UTSG was established to promote transport teaching and research in universities and institutions of higher education in the UK and Ireland. Although membership is open to individuals in other countries, the mailing list maintains a strong UK focus.

3. *Direct Mail Response Rates*, **The Direct Mail Information Service (2005).**

4. One implication of this is that, if relying on responses alone, this survey limitation would probably not have been detected from an upfront, smaller-sample pilot survey.

Figure 5: The responses revised when given other options.

	TMIP	UTSG	Combined
Art	21%	25%	23%
Science	26%	16%	22%
Both	50%	48%	49%
Other	3%	11%	6%

CONTACT DETAILS

For a number of years Robert Bain worked for the credit rating agency Standard & Poor's. He was a Director in the firm's Infrastructure Finance Ratings practice with responsibility for transportation projects and public-private partnerships. Today he runs his own consultancy conducting infrastructure investment analysis. Much of his work involves reviewing transport models and demand forecasts for banks, infrastructure funds and institutional investors. For more information see www.robbain.com or contact Robert at info@robbain.com.