Models and Modelling: A Case Study



(Magritte, 1929)

# Dell’s Channel Transformation: Leveraging Operations Research to Unleash Potential Across the Value Chain

## Introduction

The purpose of this essay is to reflect on aspects of models, as used in the field of Management Science, and on the modelling process itself, with particular reference to the industrial case study (Martin et al., 2014) that appears in the title above. The article chosen was published in the Operations Research journal *Interfaces* in January 2014 and was a finalist in the 2103 Franz Edelman Awards competition, an annual contest designed to highlight exceptional examples of OR/MS practice.

At the time of publication, Dell Inc. was the world’s third largest personal computer vendor in terms of market share (iCharts, 2014). In their paper, the authors describe three main “solutions” [models] that were developed in response to Dell’s transition from a predominantly configure-to-order (CTO) sales approach to a supply model that emphasised delivering fixed hardware configurations (FHCs), as part of a response to evolving customer attitudes to purchasing technology, including personal computers. For the purpose of this essay, the focus will be on just one of these three models, namely that which the authors refer to as the “Online Conversion Rate Accelerator” (“OCRA”).

## Online Conversion Rate Accelerator

The Online Conversion Accelerator is, in essence, a model of the various components that appear on a sales web page on Dell’s website, along with certain technical and business constraints, formulated as a non-linear, mixed-integer program. More specifically, the objective function is to maximise the “conversion rate” (that is, the proportion of customers browsing the web page who then progress to placing an order) which is modelled as the sum of the “main effects” and “interaction effects” relating to a specified set of permissible webpage components, such as “buttons” and “deal banners”, with each component represented by a binary variable and an associated coefficient. The model constraints include a specified minimum and maximum number of page components; merchandising restrictions on certain combinations of FHCs being displayed on the same web page; a restricted permissible set of combinations of page components (based on a sub-model, to be discussed later in this essay); upper and lower bounds for product prices; limitations on permutations of website navigation elements; and an upper limit on the time taken for a web page to load, given its constituent parts.

The model described above is in fact the final link in a chain of three models, with the inputs to the above model being derived from another that utilises multivariate testing and A/B testing to generate a set of distinctive permutations of web page components. The authors refer to each of these permutations as a “recipe”. Extending the authors’ analogy, the ingredients for these recipes stem, in turn, from the initial model in the sequence, that was designed to generate a complete inventory of the individual elements of web page design that have a bearing on the conversion rate. The reported methods used to isolate these components include some that are widely used and recognised, such as key driver analysis and text mining, as well as borrowing from more specialised techniques from the literature, including behavioural analysis (Padmanabhan and Tuzhilin, 2003), website-specific usability testing (Hinchliffe and Mummery, 2008) and pathing analysis, an approach that analyses user/website interaction based on website metrics data (Weischedel and Huizingh, 2006).

The stated purpose of the OCRA model, as defined by the model’s objective function, was to maximise the online customer conversion rate. Additionally, the authors appear to have linked the model to two further outcome measures, namely online customer satisfaction and “margin improvement”, although the motivation and basis for doing so is unexplained in the text. It appears that the degree of customer satisfaction may have been assessed by means of a questionnaire: the paper states that “…the overall satisfaction of online FHC customers improved from 27 to 45 percent as a result of the improved purchase path”. It is difficult to draw any firm conclusions from this assertion. Presumably it does not mean that, on average, individual customers went from being “27% satisfied” to “45% satisfied”, as it is difficult to conceive such a measure being valid. More probably, the implication is that the proportion of respondents indicating a certain, subjective, qualitative level of satisfaction with the purchasing process increased from 27% to 45% [one hopes that the measure was not simply a binary choice between “satisfied” and “unsatisfied”!]. Even so, the latter portion of the statement (“as a result of the improved purchase path”) lacks justification, and one might speculate that other, confounding variables, such as price, which is well documented as exerting a significant influence over customer satisfaction in the online retail environment (Jiang and Rosenbloom, 2005) may be at play here[[1]](#footnote-1). Similarly, the claim that “a margin improvement of $33.5 million” was as a direct result of “implementing various changes recommended by these OCRA processes” is somewhat tenuous and left uncorroborated. With regards to the objective function of the model, the online customer conversion rate, the authors report that “various merchandising changes made as part of OCRA helped increase the online FHC sales mix from seven percent in 2010 to 38 [sic] percent in 2012”. There are a number of issues with this statement. To begin with, the proportion of sales that are FHCs is clearly not the same as the stated objective, that is the proportion of visitors to the sales page who subsequently go on to complete a purchase. Further, as with the two previous claims, in the absence of evidence for a causal relationship, the predicate of the statement is something of a *non sequitur*: one might reasonably speculate that an increase in FHCs as a percentage of all sales could be anticipated simply on the basis of Dell switching to a FHC sales model, optimised or not, in preference to a CTO sales model.

The Online Conversion Rate Accelerator model was developed with a view to informing senior executives within Dell, specifically Dell’s “online business managers” (OBMs). Interestingly, whilst regional variations of the model were generated (on the basis of location-specific constraints), the models were implemented centrally by a “global project management team”. There appears to have been an initial degree of reluctance to accept and adopt the model, apparently owing to the fact that some of the model’s conclusions were contrary to existing beliefs: the authors describe the example of an unanticipated, inverse association between the number of deal banners on a web page and the associated conversion rate. This preliminary resistance dissipated, seemingly on account of the results of successive, incremental “pilots” of the model, leading progressively to managerial acceptance, subsequent full-scale roll-out and finally to adoption in preference to the prior approach of page design based on expert knowledge and acumen.

# What constitutes a “good” (Management Science) model, and what are the characteristics of a good modelling process?

## What constitutes a “good” model?

The use of the word “model” in English dates back to the latter half of the 16th century, according to at least one online source (Etymonline.com, 2014):

[model (n.)](http://www.etymonline.com/index.php?term=model&allowed_in_frame=0)

1570s, "likeness made to scale; architect's set of designs," from Middle French modelle (16c., Modern French modèle), from Italian modello "a model, mold," from Vulgar Latin \*modellus, from Latin modulus "a small measure, standard,"

This primordial definition of a model may suffice for certain instances of physical models, but lacks the qualities necessary to capture the sophisticated essence of what we mean by a model in our specified context. The question as to what constitutes a good Management Science model is perhaps best answered by separating the question into two constituent parts as follows. First, the shorter (but not necessarily simpler) question, “What is a model?”, and second “How does one define ‘good’ in this context?” For each of these questions, it is also apropos to enquire, “According to whom?”

In constructing a response to the first question, “What is a model?”, both Williams (Williams, 2008) and Wahlström (Wahlström, 1994) utilise a definition taken from the Collins English Dictionary (1986) as a starting point:

“a simplified representation or description of a system or complex entity, especially one designed to facilitate calculations and predictions”

[Fast forward to the present day, and that definition remains unchanged (Collinsdictionary.com, 2014).] This, surely, represents an improved definition from our chosen perspective, providing a description that is more detailed and that uses a vocabulary that seems more applicable to the realm of conceptual, rather than physical, models. The definition introduces the concept of the distinction between a detailed and intricate actuality on the one hand, and a less complicated portrayal of that reality on the other, before alluding to the notion of a model having a purpose. From here, the authors diverge in their approach to answering the question of what constitutes a model. Wahlström progresses to effectively describe a “model of a model” and whilst such an approach has merit, it lacks concision and leaves us yet to clear the first hurdle in our pursuit of a definition that is, at once, sufficiently succinct and yet satisfactorily comprehensive (a duality that applies, as we shall see, to the very models that we seek to describe). Conversely, Williams continues with what might itself be considered a small-scale modelling exercise: using the dictionary definition as a prototype for the finished product; describing a sequence of iterations in which he reflects on elements of the growing definition; refining each element in turn whilst also adding components deemed necessary to encapsulate the essence of a Management Science model, before arriving at the endpoint – a “model” defined in a single sentence, thus:

“A model represents or describes perceptions of a real situation, simplified, using a formal, theoretically based language of concepts and their relationships (that enables manipulation of these entities), in order to facilitate management, control, understanding or some other manipulation of that situation.”

1. “One of the first things taught in introductory statistics textbooks is that correlation is not causation. It is also one of the first things forgotten.” (Sowell, 1995) [↑](#footnote-ref-1)