Forecasting Urban Travel
Past, Present and Future

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How did the Book come about?

- We first met at the Institute for Transport Studies at the University of Leeds in 1972, and compared notes on US and UK urban transportation studies.

- In 2003, we began to write on a comparison between model developments in US and UK.

- In 2007, we finalised a book outline on the history of ideas underpinning models and methods for forecasting.

- In 2014, the first draft was completed!

What were our Objectives?

- Write history of the development of the field in terms of influential ideas.

- Consider innovations in relation to existing knowledge and 'spirit of the times.'

- Explore how innovation was transferred over time and space.

- Draw in contributions from mathematics, statistics, physics, engineering, operational research, economics, geography and psychology.

- Establish a literature which we hoped would be useful to the field.

- Hoped to make a contribution that was widely accessible to academics, professional planners, students and the interested citizen.

What were our Methods?

- Drew on our own experience in particular areas.

- Consulted national and international literature, read/reread major papers and reports produced over the last 60 years.

- Wrote to many key figures in the development of the field.

- Consulted many current theoreticians and practitioners about the current states of the art in particular areas.

- Circulated chapters widely to check their accuracy and integrity.

The style of the book

To fulfil our 'accessibility' objective:

- No mathematics in the text (Hawking's Law).

- Technical details and further reading in the chapter end notes.

Models and their uses

- Representations of the behavior of a system
  - changes over time
  - changes in response to policies

- Policies very wide ranging

- Generate information of interest to planners and policy makers

Establish themes of development and innovation

Within a broadly chronological approach, we considered the following themes:

- Role of institutions in developing, sponsoring and promoting models

- Planning contexts, information requirements

- Nature and relevance of theory

- Data requirements of models and methods

- Solution of models

- Validation and performance of models

- Practical compromises in model development

Chapter 2: Emergence of the traditional approach

- Impetus for urban transportation studies.

- Role of forecasting and plan testing in the Detroit and Chicago areas.

- Major advances in zone-based land use, generation, distribution and assignment models.

- Urban transit and inter-zonal modal split models.

- Consolidation of the three-step and four-step approaches.

- Role of the Bureau of Public Roads and US HUD.

- Land use - transportation studies and the development of land use models.

- Rise and fall of 'large scale' models?

Chapter 3: <u>Early developments in the UK</u>

- Early 1960s: Transfer of the technology of forecasting from North America

- 1965-7: zone-based to household class-based models.

- 1967-9: generalised costs and VoT expressions.

- 1967-9: Entropy maximising models introduced

- Empirical to analytic forms for location, mode and route splits.

- Much improved representation of public transit systems

- 1969 SELNEC Study: incorporates all major developments

Chapter 4: Developments in discrete choice models, 1970-1976

- Disaggregate models and methods based on rational choice.

- Major progress in forecasting approach based on specification, estimation, aggregation, and validation of discrete choice models.

- Wide application of multinomial logit (MNL) models particularly to modal choice and related problems.

- Early exploration of model structure (e.g., to combined choices).

- Increasing application of 'disaggregate behavioural' approach in the US, UK and Netherlands.

- Contrasts between 'new' and 'traditional' approaches emphasized

Chapter 5: Further developments in discrete choice models, 1976 →

- Major theoretical efforts in US and UK to address the problem of similarities between alternative choices

- Nested Logit and GEV family extensions established

- Traditional forecasting model reinvented in behavioural clothes. Anomalies found in forecasts!

- Numerical methods applied to address more complex choice processes. Micro-simulation methods used more widely.

- Stated preference methods developed and officially supported.

- Testing of 'disaggregate behavioural' approach (USA and Netherlands).

- 1980s onwards. Major theoretical and empirical work on choice processes.

Chapter 6: Activity-based travel analysis and forecasting

- Late 1970s / early 1980s: broad critique of economic models as a basis for explanation and forecasting of travel behaviour.

- Empirical studies on complexity of choice processes and organisation of activities and travel in space and time

- Early 1990s: 'Towards a new generation of travel demand models'.

- Tour-based and schedule-based approaches to activity-travel analysis.

- Econometric and 'computational process' models approach operational status.

- Current status: 'Grand behavioural synthesis' sought with marriage of choice-based and constraint-based approaches.

Chapter 7: Transportation network <u>equilibrium</u> <u>models</u>

- 1952: Wardrop's two criteria established.

- 1956: Beckmann-McGuire-Winsten network equilibrium model formulated.

- Exploration of combined model as an alternative to the traditional four-step procedure.

- Classification of problems on basis of demand function (fixed/variable) and cost functions   (symmetric / asymmetric).

- Solution algorithms proposed and convergence properties examined for various combined models. Rigorous solution procedures replaced four-step heuristics. 'Feedback' examined in detail.

- Challenges remain for multi-modal, multi-time period models with more realistic link cost functions.

Chapter 8: Tradition and Innovation in US practice

- Evolving requirements for urban travel forecasting (Clean Air Act Amendments, 1990).

- Responses of the MPOs limited and main tradition of practice unchallenged.

- Applications of tour-based and activity-based models.

- New travel forecasting initiatives – TRANSIMS a work in progress (?).

- Major developments of applied land use - transportation models.

- Weaknesses of traditional urban goods movement models widely recognised: vehicle-based, commodity-based and agent-based approaches

Chapter 9: Tradition and innovation in <u>UK</u> <u>practice</u>

- Few comprehensive tour-based or activity-based models (e.g., PRISM).

- Incremental (pivot-point) models widely used and officially supported.

- Major studies on significant responses to policies and corresponding elasticities.

- Journey timing decision increasingly modelled.

- G/D/M/A no longer used as default → G/M/D/A increasingly supported.

- Stated preference approaches widely adopted and officially supported.

- More network detail in space and time (e.g., SATURN, micro-simulation)

- Major advances in Integrated LU-T models

Chapter 10: Computing environment and <u>travel</u> <u>forecasting</u> <u>software</u>

- Our field and digital computing for civilian use grew up together.

- Development in hardware allowed innovations in models and software products.

- Developments of hardware for mainframe, mini- and micro-computers reviewed.

- Comparisons of computing speed, memory and cost.

- Travel forecasting software for mainframe, mini- and micro-computers examined.

- Travel forecasting software developers and products reviewed.

Chapter 11: Achievements, current <u>challenges</u> <u>and</u> <u>future</u> <u>prospects</u>

- Summarised progress in five stages.

- Challenges of behavioural modelling abound

- Still searching for internal consistency of complex models in practice.

- Assumptions underpinning forecasts and performance of models increasingly seen to be subject to challenge.

- Conflicts and compromises between 'practice' and 'research'

- The role of the critic is vital for constructive innovation.

- Major challenges related to modeling new technological initiatives, innovative policies, etc.

- How will the field develop in an age of 'big data' and new means of data collection?

Chapter 12: <u>Conclusion</u>

- How was progress achieved?

  - Progress through a series of paradigm changes?
  - Where do/did 'good' ideas come from?

- Handing on the experience and learning in the process

  - How will future progress be judged?
  - Need to make our field more transparent to everyone, including interested citizens.

What happened next?

- We tried to consult widely on individual topics:
  - Approximately 100 people approached for advice, and read selected passages
  - 10 people read several chapters

- Draft of final manuscript submitted in June 2014
  - Published in UK in April 2015
  - Published in US and Rest of World in June 2015

- Paperback edition will appear by mid-2016.

- We welcome comments / critiques on omissions / inaccuracies and biases
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