Expanding the World of Theory of Constraints

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Victoria Business School
Wellington
New Zealand
Aims and background

• Aim – to bridge gap between academics and practitioners and to hold a mirror to see what outsiders see of TOC (what is available to academic researchers on TOC? What view are we presenting to the academic world?

• Database to record:
  TOC publications available in the published ‘academic’ literature
  Follows on from The World of the Theory of Constraints bibliography
Acknowledgements

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The Goldratt Foundation

We also acknowledge and appreciate the input and guidance from our advisors:
• Emeritus Professor James Cox, University of Georgia at Athens, and TOCICO Board Member
• Steven Balderstone, Revive Business Improvement, Australia
• Marcia Hutchinson, General Manager, TOCICO
• Rami Goldratt, Goldratt Foundation

And thanks to all who supported us by keeping an touch and informing us of new publications
Welcome to the Theory of Constraints (TOC) online resource, which aims to support collaboration between researchers and practitioners in the field.

About the Theory of Constraints database
A database of TOC articles, books and conference papers was started back in 1996, with our first bibliography published in 2000. We have recently searched the literature and updated our records and have now assembled over 4000 articles, books, and conference papers, on all areas of TOC. The database here contains journal articles and conference papers, to complement the listing of TOC books compiled by Prof Jim Cox, which is available on the TOCICO website.

This evolving database will be published via regularly updated spreadsheets that build on the great work done to date, and available as a downloadable resource for researchers and practitioners alike.

Database Categories
- Critical Chain Project Management (CCPM) (updated April 2016)
- Thinking Processes (updated April 2016)
- Throughput Accounting (updated April 2016)
- Supply Chain & Operations Management (updated April 2016)

For each paper, we provide a link to the source. Some of the entries contain links to the actual articles, but copyright laws prevent us from providing copies of every paper.
Overview of publications

2016 TOCICO International Conference
Who is publishing?

Major Authors in academic Database

- Ronen, B.
- Cox, J.F.
- Mabin, V.J.
- Gupta, M.
- Davies, J.
- Chakravorty, S.S.
- Wang, J.Q.
- Sun, S.D.
- Schragenheim, E.
- Coman, A.
- Vrînciuț, M.
Where are TOC academic papers published?

Top 10 journals by frequency

- International Journal of Production Research: 146
- Management Accounting (USA) and (UK): 95
- Production Planning and Control: 66
- Production and Inventory Management Journal: 45
- Computer Integrated Manufacturing Systems, CIMS: 27
- Industry Week: 23
- International Journal of Project Management: 21
- European Journal of Operational Research: 20
- International Journal of Production Economics: 20
- International Journal of Operations and Production Management: 17
Where are TOC academic papers published?

Top journals (A+)

- International Journal of Production Economics
- European Journal of Operational Research
- Journal of Construction Engineering and...
- Journal of Operations Management
- Omega
- Management Accounting Research
- Journal of Information Technology
- Automation in Construction
- Industrial Marketing Management
- Management Science
Where are TOC academic papers published?

Overview of ranking

<table>
<thead>
<tr>
<th>Category</th>
<th>Total</th>
<th>Operations</th>
<th>CCPM</th>
</tr>
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<tbody>
<tr>
<td>A*</td>
<td>2.91%</td>
<td>2.67%</td>
<td>3.70%</td>
</tr>
<tr>
<td>A</td>
<td>13.14%</td>
<td>14.54%</td>
<td>8.62%</td>
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<tr>
<td>B</td>
<td>5.00%</td>
<td>5.40%</td>
<td>3.70%</td>
</tr>
<tr>
<td>C</td>
<td>4.22%</td>
<td>5.02%</td>
<td>1.64%</td>
</tr>
<tr>
<td>Other Journals</td>
<td>44.57%</td>
<td>49.84%</td>
<td>27.52%</td>
</tr>
<tr>
<td>Conference Proceedings</td>
<td>30.16%</td>
<td>22.54%</td>
<td>54.83%</td>
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Classification of papers

- Operations management: 1000
- Project management: 638
- Throughput accounting: 296
- Thinking process tools: 247
- Supply chain: 44
Process of analysing the papers

Total of 919 papers categorised as operations management including papers that applied TP to operations management

  110 papers were found to be only referring to TOC briefly and moving to other topics so were excluded from further analysis.

The analysis went through multiple iterations using NVivo, and were coded to maximum of five nodes

Initially the papers were divided into two major categories:

• **Methodological improvement**
  – Conceptual development
  – Scheduling algorithms/mathematical development

• **Application**
  – Manufacturing
  – Service industry
A large number of conceptual papers were introductory (still)

Next largest group: papers comparing and contrasting TOC with other methods (we identified 40) e.g MRP, ERP, JIT, Agile, Lean, CONWIP, Six Sigma, and TQM.

There were also a few critiques
  — Bottleneck concept
  — DBR
  — Reducing variability - a forgotten option
Methodological improvement

Mathematical development

Mathematical development for proposing, comparing, validating particular sequencing and/or scheduling techniques. These comprise:

- 40% of all OM papers (319 papers)
- 70% of TOC publications in A+ Journals (31 out of 44)

Simulation analysis (219 papers)

Nearly half (21 out of 44) of Publications that made it to A+ Journals used simulation to evaluate:

- DBR performance
- Heuristic decisions (batch sizing, buffer sizing, inventory trade-offs)

Mathematical algorithms (108 papers)

28% of these papers used Fuzzy theory (30 papers)
Application to Manufacturing

Context

Machine-shop
Electronics
Automobile
Furniture
Construction and construction material
Food industry
Machinery production
Shipbuilding
Print
Clothing industry
Oil and gas
Others
Processes used

Some organisations abandoned past practices replacing them with TOC and a holistic way.

Others applied some TOC techniques into their existing practices.

- Majority of reports applied 5FS
- We identified 16 reports of application of DBR
- Few applications of thinking process tools
- Only one report on application of SDBR
- Hybrid models: e.g. TOC & MRP & JIT
Results of TOC application

Difficulties in obtaining quantitative data from existing published records of TOC application

Different manufacturers confront different types of problems

TOC application varies in different contexts

Different scholars report different types of improvements

Insufficient information

Approaches used to evaluate TOC performance:

1. By analysing how TOC adopters perform compared to other manufacturers. (e.g. Sale and Inman, 2003)

2. By analysing correlation between adoption of various TOC method’s and organisation performance in a large pool of TOC and non TOC adaptors (e.g Inman, Sale, and Green, 2009)

3. By analysing the impact of using TOC on performance of an organisation before and after TOC adoption (from published case studies) (e.g . Balderstone and Mabin, 1998, World of TOC, 2000, IJOPM 2003)
Application to Services

Context – case studies and suggested application areas

- Healthcare: 48%
- Administration: 13%
- Insurance, bank, and finance: 8%
- Shipping services: 6%
- Education: 5%
- Engineering: 4%
- Security Services: 3%
- Internet services: 3%
- Airline: 3%
- Court system: 3%
- Photography: 3%
- Hospitality: 1%
Application to Services

Process

Practices within service industry **healthcare**: Major focus has been on flow, care pathways, and healthcare logistics:

- Application of DBR
- Hybrid methods (TOC, Six Sigma, business process redesign, Lean, and simulation)

A few applied Thinking Process tools

5FS and TOC measurements system

Practices within Administration

- Five focusing steps
- Application of DBR and VATI analysis
- Hybrid methods (TOC, Six Sigma, business process redesign, Lean, and simulation)
Application to Services

Result

Service industry presents a smaller but growing application area compared to manufacturing

The results of application are also not as good as in manufacturing

Some of the reasons:

Visibility as barrier to adopting TOC in service industry

Perceived disadvantages of focus on flow in healthcare:

- dehumanises the process
- reducing the patient’s choices and personal relationship between the health professional
- potential mistrust caused by control mechanisms
### Most cited papers* – Scopus

**2016 TOCICO International Conference**

<table>
<thead>
<tr>
<th>Title</th>
<th>Author(s)</th>
<th>Year</th>
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<tbody>
<tr>
<td>Constraint hierarchies</td>
<td>A. Borning, B. Freeman-Benson and M. Wilson</td>
<td>1992</td>
<td>125</td>
</tr>
<tr>
<td>Theory of constraints and linear programming: A comparison</td>
<td>R. Luebbe and B. Finch</td>
<td>1992</td>
<td>100</td>
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<tr>
<td>Drum-buffer-rope shop floor control</td>
<td>E. Schragenheim and B. Ronen</td>
<td>1990</td>
<td>100</td>
</tr>
<tr>
<td>Soft-sensing of level of satisfaction in TOC product-mix decision</td>
<td>A. Bhattacharya and P. Vasant</td>
<td>2007</td>
<td>95</td>
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<tr>
<td>heuristic using robust fuzzy-LP</td>
<td></td>
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<tr>
<td>Solving the integrated product mix-outsourcing problem...</td>
<td>S. Nazari-Shirkouhi, H. Eivazy, R. Ghodsi, K. Rezaie and E. Atashpaz-Gargari</td>
<td>2010</td>
<td>87</td>
</tr>
<tr>
<td>Improving the product mix heuristic in the theory of constraints</td>
<td>L. D. Fredendall and B. R. Lea</td>
<td>1997</td>
<td>83</td>
</tr>
<tr>
<td>Applying the theory of constraints to supply chain collaboration</td>
<td>T. M. Simatupang, A. C. Wright and R. Sridharan</td>
<td>2004</td>
<td>80</td>
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* Based on search using “theory of constraints”
**Most cited papers** – Google scholar

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<tr>
<td>D Nave (2002)</td>
<td>How to compare six sigma, lean and the theory of constraints</td>
<td>300</td>
</tr>
<tr>
<td>H Steyn (2002)</td>
<td>Project management applications of the theory of constraints beyond critical chain scheduling</td>
<td>224</td>
</tr>
<tr>
<td>JH Blackstone (2001)</td>
<td>Theory of constraints-a status report</td>
<td>190</td>
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<td>Theory of constraints and linear programming: a comparison</td>
<td>183</td>
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Mathematical developments make it into A+ journals

Only 7% of A+ papers and none of most cited papers describe actual applications

Most cited papers are

- Introductory papers
- Literature reviews
- Comparative analysis
Implications

• Where to from here?

• How can we make more up to date information on TOC available to outsiders eg
  – White papers on new methods/knowledge
  – Academic papers
  – Applications papers
  – More papers on current trends
Please email us at toc@vuw.ac.nz if you:

• know of other papers to add
• have a particular paper you need help to access
• want to add or make any changes to an entry
• want to discuss the possibility of collaborative research or give some feedback
• would like to be kept informed of any major updates or additions to the database