First principles and transportation policy

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First principles

**Things they tried to teach us in school**

Okay, now listen up. Nobody gets in here without answering the following question: A train leaves Philadelphia at 1:00 p.m. It's traveling at 65 miles per hour. Another train leaves Denver at 4:00... Say, you need some paper?
Foggy language ➔ soggy thinking

Pseudo-scientific obfuscation

• “This story has been optimized for offline reading on our apps”
  – *Washington Post*, article on Donald Trump, 2 November 2017

• “Carefully formulated to optimize your ownership enjoyment”
  – placeholder quote, surely everyone has read junk like this
First principles

Ubiquitous, but always subject-specific

- Physics: $f = ma$, wave velocity = $f \lambda$, electrical power = $i^2 r$
- Chemistry: $pv = nRT$, molarity = $x$ moles / $y$ litres
- Algebra: if $a = b$ and $b = c$, then $a = c$
- Trigonometry: $\sin \theta = y/r$, $\sin^2 \theta + \cos^2 \theta = 1$
- Mechanics: work = force x distance, lateral acceleration = $v^2/r$
- Logic: a statement and its contrapositive are logical equivalents
- Economics: supply withheld below equilibrium demand $\Rightarrow$ rent-taking
- Business: inventory turnover rate = sales per unit time / mean inventory
- Psychology: Maslow’s 1st level of needs trumps 4th level
- System optimization: the end result of many local optima is not the optimum of the total system
Aircraft carrier design

Choosing the KPIs judiciously

USS Gerald R. Ford (CVN 78)
Russia’s transition to a market economy

Getting the process wrong

- IMF demanded balanced budget, loans denominated in $US
- Ruble deflated, capital fled, loans defaulted, oligarchs won
- US refused nation-building aid package like Marshall Plan
- First principles not sufficiently invoked:
  - path-dependent events
  - rent-taking as a function of cronyism
Moving Canada’s freight to market

How systems work

- Total Quality Management, Just-in-Time, Theory of Constraints
  - *optimizing a system of production*
  - embodied in logistics and supply-chain design
  - embodied in Asia Pacific Gateways and Corridors Initiative
  - largely ignored in C-52 and C-30, largely respected in C-49

- System stability—avoiding positive feedback loops
  - largely ignored in C-52 and C-30, largely respected in C-49

Edwards Deming
Mathematical physics

Eliyahu Goldratt
Physics

Heinrich Barkhausen
Physics, Electrical engineering

Jay Forrester
Electrical engineering
Moving Canada’s freight to market

Positive feedback loops

- Theory originated in electrical, electronics engineering
- Applies to other fields—psychology and economics
  - examples: run on the bank, sovereign debt crisis in Europe
  - sometimes called “vicious circle” or “self-fulfilling prophesy”
- Economic regulation of transport ↔ congestion:

  - Shipper dissatisfaction with railway service
  - Congestion in rail traffic movements
  - Shipper complaints to government
  - Government regulation
The phenomenon of mobility

Too much of a good thing

Notional throughput vs. density on a traffic artery

High risk zone for collapse of speed and throughput

Sweet spot for undelayed travel

Sweet spot for maximum throughput

Collapse of speed and throughput
Financing transportation infrastructure

It isn’t getting better all the time

- Canada Infrastructure Works Fund (1994 – 99)
- Canada Strategic Infrastructure Fund (2003 – 13)
- Infrastructure Canada Program (2003 – 14)
- Public Transit Fund (2003 – 14)
- Border Infrastructure Fund (2003 – 14)
- Municipal Rural Infrastructure Fund (2004 – 14)
- Building Canada Fund (2007 – 14) (15 priorities)
- P3 Canada Fund (2007 – 14?)
- National Recreational Trails Fund (2009 – 10)
- Infrastructure Stimulus Fund (2009 – 12)
- G8 Legacy Fund (2009 – 11)
- New Building Canada Fund (2014 – ) (20+ categories)
- Community Improvement Fund
- Goods and Services Tax Rebate for Municipalities
- Public Transit Infrastructure Fund
Fluidity, resilience, and optimization of supply chains

Going mobile

• **Fluidity:**
  – embodies the concept of conveyor-belt consistency
  – based on optimization theory and traffic theory

• **Pursuit of fluidity and resilience ➔ then optimization:**
  – avoid / reduce / deal with *variation* and its effects:
    • decreased throughput
    • decreased quality of what the system produces
    • increased work-in-progress inventory ( = backed-up traffic)
    • stretched-out delivery times to end-customers
    • longer lead-times for customers
    • reduced efficiency

• **TC doing some leading work in pursuit of:**
  – KPIs that are “key”
  – data that bring KPIs to life
Counterintuitive wisdom

Thoughts from the deep

• A proof is a proof. What kind of a proof? It’s a proof. A proof is a proof. And when you have a good proof, it’s because it’s proven.
  – Jean Chrétien

• A system will optimize in the direction of the primary Goal
  – Eliyahu Goldratt

Corollary: any KPI not based on 1st principles is misleading

• Data without theory is useless
  – Edwards Deming

• To understand the world, the average is rarely good enough
  – Angus Deaton

• Stochastic data fed into a deterministic system yields nothing
  – Chris Winkler
In conclusion

• Recognize we have a problem:
  – too much politics, not enough policy
  – too little recognition of 1st principles

• Always start by figuring out the primary Goal

• Sweat the determination of KPIs that crystallize “performance”

• Cheer on TC’s pursuit of fluidity concepts and metrics

• Insist on evidence of gains in mobility, substantiated by 1st principles, for all transportation investments and policies

• Make space at the table for people who can animate theory
What to do?

In conclusion

• Be nice to nerds . . .
  – even if “chances aren’t good that you’ll end up working for one”
    – with apologies to Bill Gates
  – because “there is nothing more frightful than ignorance in action”
    – Johann von Goethe