Optimisation - Myths and Fact

Optimisation

- Single most mis-represented aspect of FCS & APS
- Terminology differences between the mathematical and manufacturing worlds
- Huge body of academic literature
- We try to avoid the word “Optimisation”
- A useful resource is
  - http://www.solver.com/

Optimisation

Optimisation

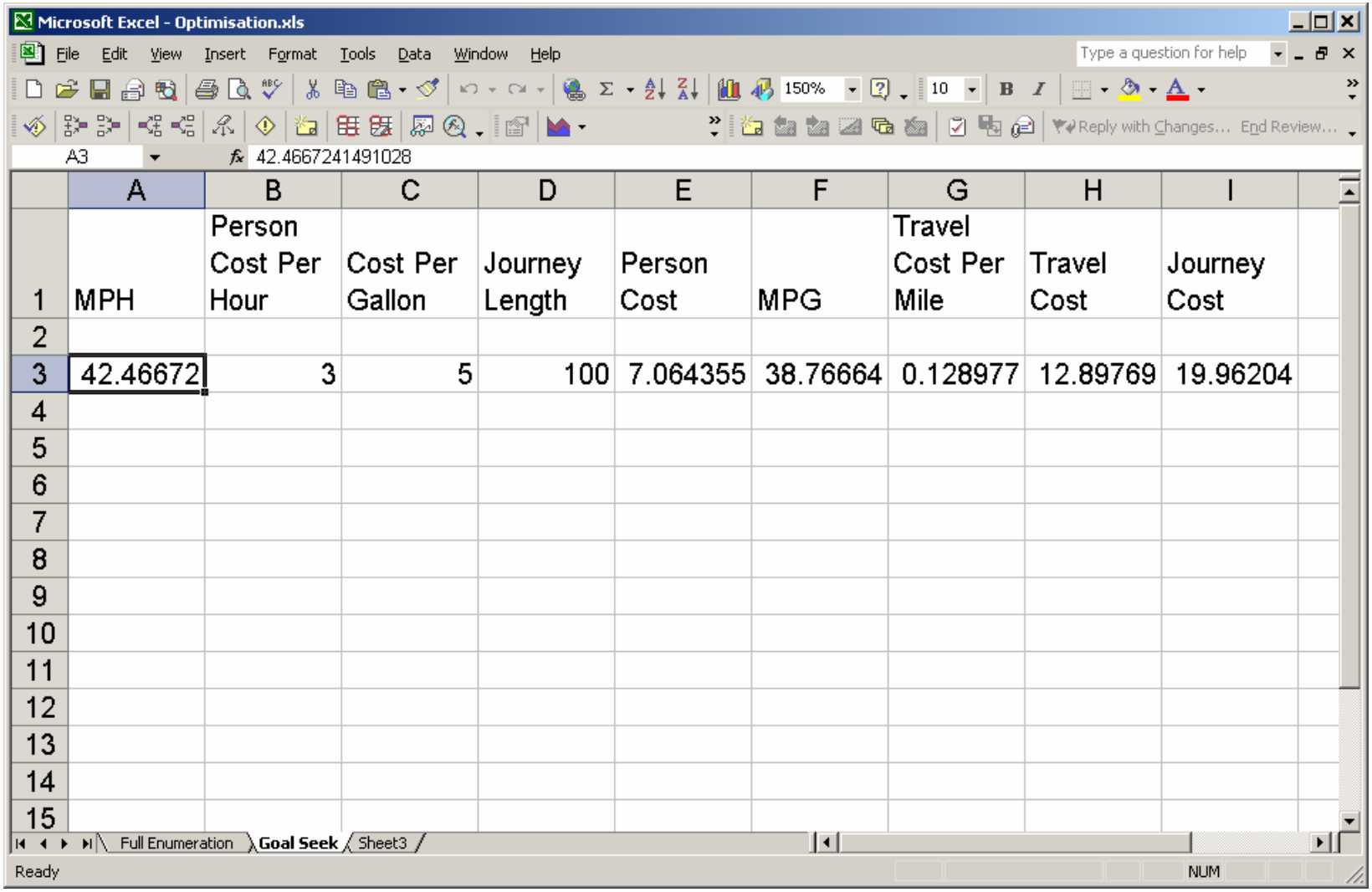
Optimisation

Simple Optimisation

Your car does 60 mpg – 0.5 mpg for every 1 mph
If you do 30 mph you get 45 mpg
If you do 60 mph you get 30 mpg
You have to travel 100 miles
Fuel costs £5 per gallon

Your time costs £3 per hour
What is the optimum speed to minimise the cost?

Optimisation



	A	B	C	D	E	F	G	H	I
1	MPH	Person Cost Per Hour	Cost Per Gallon	Journey Length	Person Cost	MPG	Travel Cost Per Mile	Travel Cost	Journey Cost
2									
3	42.46672	3	5	100	7.064355	38.76664	0.128977	12.89769	19.96204
4									
5									
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Optimisation

Manufacturing Optimisation - Typical Applications

- Maximise profit
- Maximise utilisation
- Minimise late deliveries
- Minimise setup time
- Minimise inventory

Optimisation - Terminology

- Variables
  - Number of possible results, i.e. different combinations
  - Usually a very large number, even for simple problems
  - Complete enumeration is possible given enough time

Optimisation

Traveling Salesman Problem

- Need to visit a number of clients
- How many possible routes
  - 4 clients = 4! = 24
  - 7 clients = 7! = 5040
  - 10 clients = 10! = 3,628,800
  - Etc.

Optimisation

Traveling Salesman Problem

- Number of solutions (and solution time) can be reduced
  - Branch & Bound
  - Linear Programming
- But even using linear programming solving the TSP for 15,000 clients on a 500MHz Alpha processor would take 22 years

Optimisation

Manufacturing is More Complex

- Many jobs (salesmen) scheduled at the same time
- Secondary resources (other than the client) may be required e.g. tools, materials, etc.
- Selection between multiple resources (clients)
- Resources (clients) may work different shifts
- Preferred sequences of work
- Alternative routes

Optimisation

Manufacturing is More Complex

- Nonlinear problems
  - "a **single IF or CHOOSE function** that depends on the variables can turn a simple linear model into an extremely difficult or even unsolvable nonsmooth model".
  - Frontline Systems (Excel Solver)

Optimisation

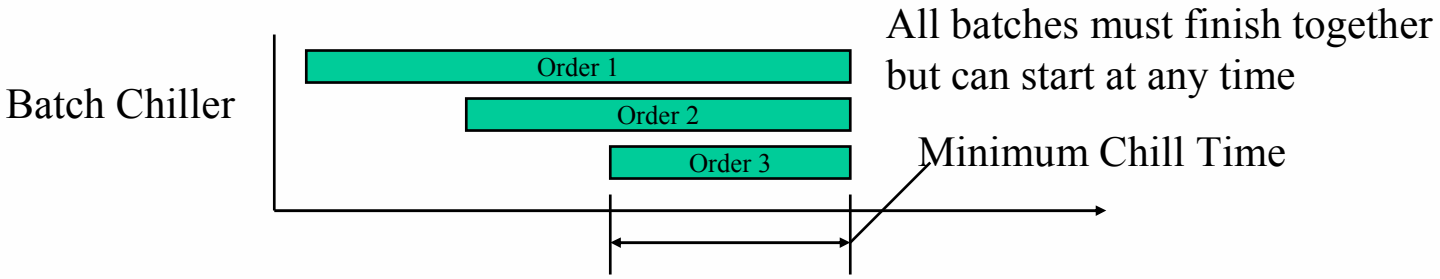
Manufacturing is More Complex

- Different goals at different process stages
- Response to changes
  - what if the schedule is not adhered to?
- The optimisation problem changes as a result of scheduling decisions
  - material wastage (life) or re-allocation
  - new problem definition required (additional constraints in the optimisation problem)

Optimisation

Manufacturing is More Complex

- Simple practical features difficult to represent
  - chilling process not a finite time (minimum time but can be extended as long as required, batch must finish at the same time)



Optimisation

Manufacturing is More Complex

- Problems are usually simplified
  - does a schedule include start and end times?
    - APICS
  - assumptions in the optimisation model
    - practical details inaccurately represented
    - resulting in infeasible schedules

Optimisation

Competitive Products

- "Genetic Algorithms are used in solving detailed scheduling problems once most of the constraint issues have been resolved"
  - SAP Advanced Planner and Optimizer (Functions)
- "AS creates schedules automatically based on Heuristic rules or Algorithms"
  - Agilisys

Optimisation

- Preactor uses
  - heuristics (priority, due date, many others)
  - time-step (simulation) loading (at each event a resource selects the “best” operation to do next)
  - multi-pass combinations of these
- Practical, feasible schedules generated in a “reasonable” time

Optimisation

Conclusions

- True optimisation is not yet feasible for manufacturing applications
- Heuristics are the best current approach
- No optimisation is worthwhile if schedule adherence is poor