



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

Optimization with Excel Solver - Frontline Systems - Microsoft Internet Explorer

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Home Learn how [optimization](#) can [allocate scarce resources](#), reduce costs and increase profits.

...and now we've raised it.

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- Genetic and Evolutionary Algorithms

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Solver Tutorial for Optimization Users

Welcome to our tutorial about **Solvers for Excel and Visual Basic** -- the easiest way to solve **optimization** problems -- from Frontline Systems, developers of the Solvers in Microsoft Excel, Lotus 1-2-3, and Quattro Pro.

- [What are Solvers Good For?](#)
- [What Must I Do to Use a Solver?](#)
- [How Do I Define a Model?](#)
- [What Kind of Solution Can I Expect?](#)
- [What Makes a Model Hard to Solve?](#)
- [Can You Show Me Step by Step?](#)

After completing this tutorial, you can learn even more about topics such as linearity versus nonlinearity and sparsity in optimization models by taking our [Advanced Tutorial](#).

What are Solvers Good For?

Solvers, or optimizers, are software tools that help users find the best way to **allocate scarce resources**. The resources may be raw materials, machine time or people time, money, or anything else in limited supply. The "best" or optimal solution may mean maximizing profits, minimizing costs, or achieving the best possible quality. An almost infinite variety of problems can be tackled this way, but here are some typical examples:

Finance and Investment

Working capital management involves allocating cash to different purposes (accounts receivable, inventory, etc.) across multiple time periods, to maximize interest earnings.

Capital budgeting involves allocating funds to projects that initially consume cash but later generate cash, to maximize a firm's return on capital.

Our [Premium Solver Platform](#) works with existing Excel Solver models, solves much larger problems up to hundreds of times faster, and solves new kinds of problems with Evolutionary Solver. New Solver engines plug into the Premium Solver Platform.

[Solver DLL Platform](#) makes it easy for your application in Visual Basic, C/C++ or other languages to solve nearly any kind of optimization problem:

- Linear programming
- Quadratic models
- Integer programming
- Nonlinear models
- Global optimization
- Non-smooth models.

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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

Microsoft Excel - Optimisation.xls

Type a question for help

File Edit View Insert Format Tools Data Window Help

150% 10 B I

A3 42.4667241491028

	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									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

Full Enumeration Goal Seek Sheet3

Ready NUM



Optimisation

Manufacturing Optimisation - Typical Applications

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



Optimisation

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

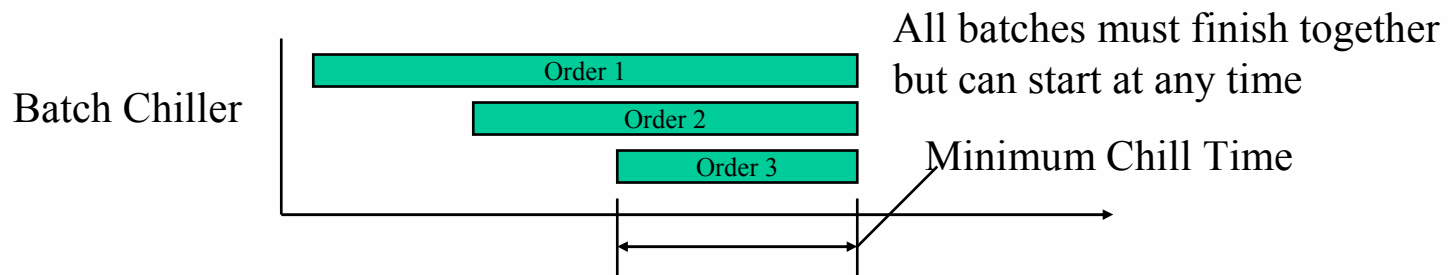
- Different goals at different process stages
- Response to changes
 - what if the schedule is not adhered to?
- The optimisation problem changes as a result of scheduling decisions
 - material wastage (life) or re-allocation
 - new problem definition required (additional constraints in the optimisation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