

# Watfactory

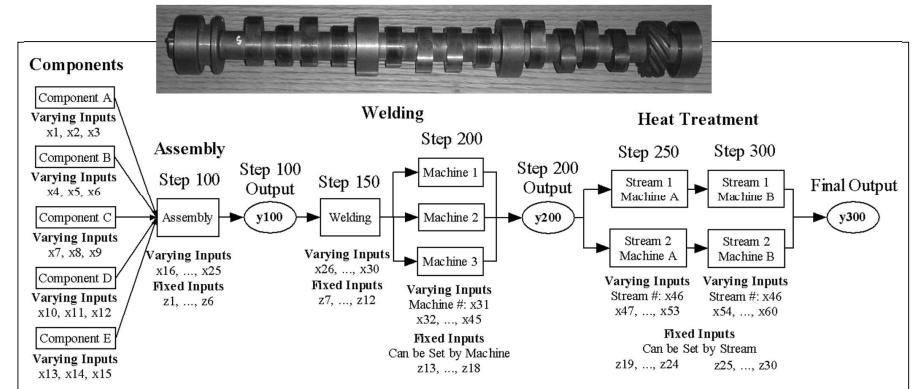
## A Virtual Manufacturing Environment for Teaching Process Improvement (and Statistics more generally!)



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# Watfactory – Camshaft Process



- There is too much variation in the straightness (can be measured at y100, y200 and final y300)
- Process runs 3 shifts, 5 days a week, 1 part per minute, i.e. 1440 camshaft are produced per day

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## Watfactory Process Inputs

- Varying inputs (x1-x60 in process map) that change as the process runs
  - Type (continuous/discrete/categorical)
  - Process step in which they act
  - History (pattern of variation over time)
  - e.g. x25 corresponds to the operator, x42 to the cooling temperature and x45 is the fixture number
- Fixed inputs (z1-z30 in process map) that are normally constant for all parts, but can be changed
  - Current level, possible range

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## Watfactory Application and Web Access

- Today's Goal: Find the main cause of variation in y300, the final critical process output (solutions, i.e. reducing variation in y300, can also be addressed in Watfactory, but today we have limited time)
- Specification range for y300 is -10 to 10
  - Budget of \$10,000 (to find solution)

### Watfactory Login Web Site

[www.student.math.uwaterloo.ca/~watfacto/login.htm](http://www.student.math.uwaterloo.ca/~watfacto/login.htm)  
 Use HamiltonASQ login with password "0000"

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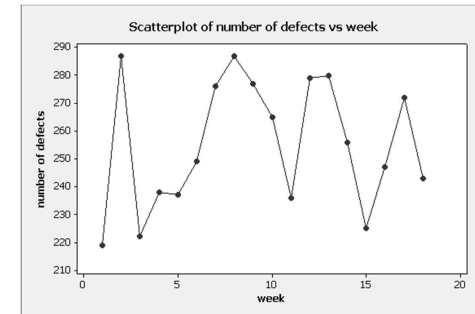
## Possible Investigations

- Observational: prospective, retrospective
- Experiments: cause verification, change fixed inputs, desensitization
- Offline experiments: measurement assessment, repeated assembly/disassembly, component swap
- Investigation costs are based on
  - Number of parts
  - measured output/inputs (e.g. output costs \$1/part)
  - Need to track parts to link inputs and output
  - Level of inputs in an experimental plan

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## Some Existing Watfactory Data

	this week	last week	same week last year	year-to-date
number of camshafts	7200	7199	7200	345564
number of defectives	243	272	230	11749
percentage of defectives	3.4	3.8	3.2	3.4



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## Use of Watfactory in the Classroom

### University Course - Stat 435/835

- Each team of 2-4 students has the same process map and background knowledge but different cause(s) and best solution(s)
- Goal is to reduce variation in the final output by ~20-40% (i.e. find cause and solution!)
- Weekly Watfactory progress report (replaces all assignments)
  - give two presentation to “management”
- Use Watfactory context for tests/exams

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## Student Experiences

- View the virtual environment and assignment as a fun game
- Must make decisions with limited and uncertain knowledge
- Are forced to repeatedly grapple with many issues related to the purpose and plan of the investigations, not part of any other course
- Can easily repeat an investigation with a different plan if needed to recover from mistakes
- Can learn from each other but cannot copy (different process versions)

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# Conclusions

- Simulation can mirror practice
- Complexity under control of instructor
- Provides a common context while allowing a different process version for each team
- Time is sped up
- Marking the assignments is challenging
  
- Teaching with Watfactory raises many issues
  - how prescriptive should we be?
  - what is best way to provide contextual information?
  - what is the best way to ask for reports