Use of variance decomposition in the early stages of WWTP design

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Objective: Quantify importance of design inputs

How are design variables affected by input ranges considered by various stakeholders?

Solution:

- Monte Carlo Simulation
- Variance Decomposition:

  → Main effects and interactions

Design Inputs and Stakeholders

Design Input	Stakeholder
Forecasting uncertainty	**Planner**
Process uncertainty and variability	**Designer**
Choice of **Safety Factor** values	**Owner / Designer**
Choice on **operational** settings	**Operator / Designer**

Case Study design objective

- Complete nitrification all-year
- No P-removal

Design guideline

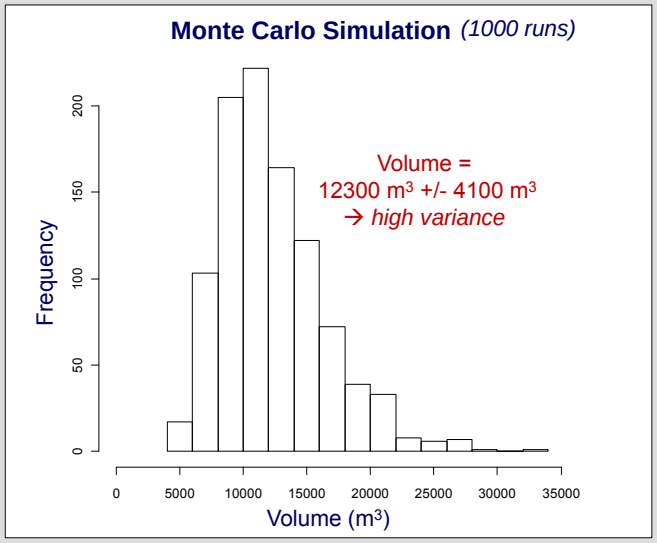
Simplified version of ATV-A 131:

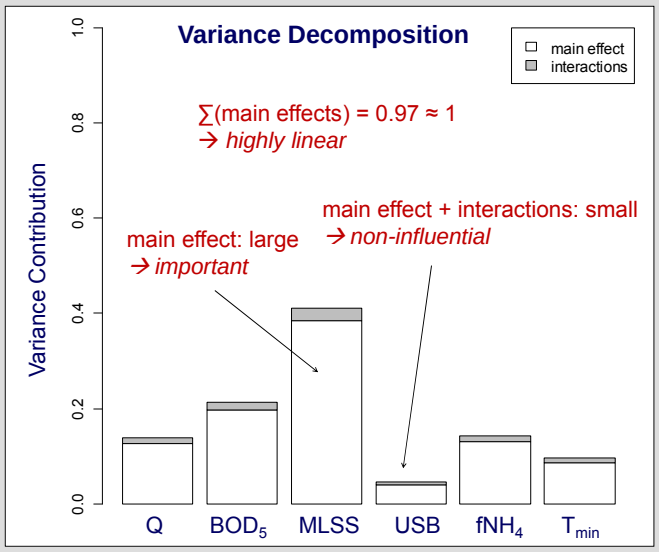
$$\text{Volume} = \frac{fNH_4}{0.29 \cdot e^{(0.11 \cdot (T_{min} - 10°C))}} \cdot \frac{(USB \cdot Q \cdot BOD_5)}{MLSS}$$

Design Input Ranges (uniform, non-correlated)

Input	min	max	Units	Description	Stakeholder
Q	32000	48000	$m^3\ d^{-1}$	Influent flow	Planner
BOD_5	0.09	0.15	$g\ m^{-3}$	BOD_5 Influent	Planner
MLSS	2	4	$kg\ m^{-3}$	Operational TSS concentration	Operator, Designer
USB	0.8	1	kg TSS / kg BOD_5	Specific sludge production	Designer
fNH_4	2	3	-	Safety factor (ammonium peak)	Owner, Designer
T_{min}	9	12	°C	Minimal temperature	Designer

Results





Conclusions

- High variance of volume
- Choice of operational MLSS: 40% variance of volume
- Uncertainty about USB: 4% variance of volume
- Volume: close to linear in design inputs

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