Changing Mindsets for Large-scale Modelling

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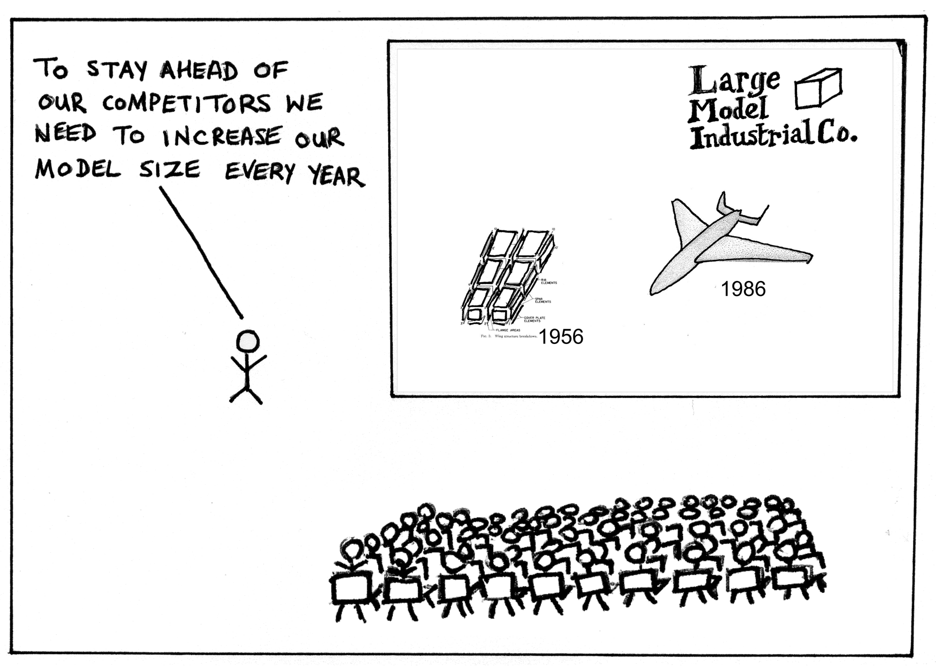
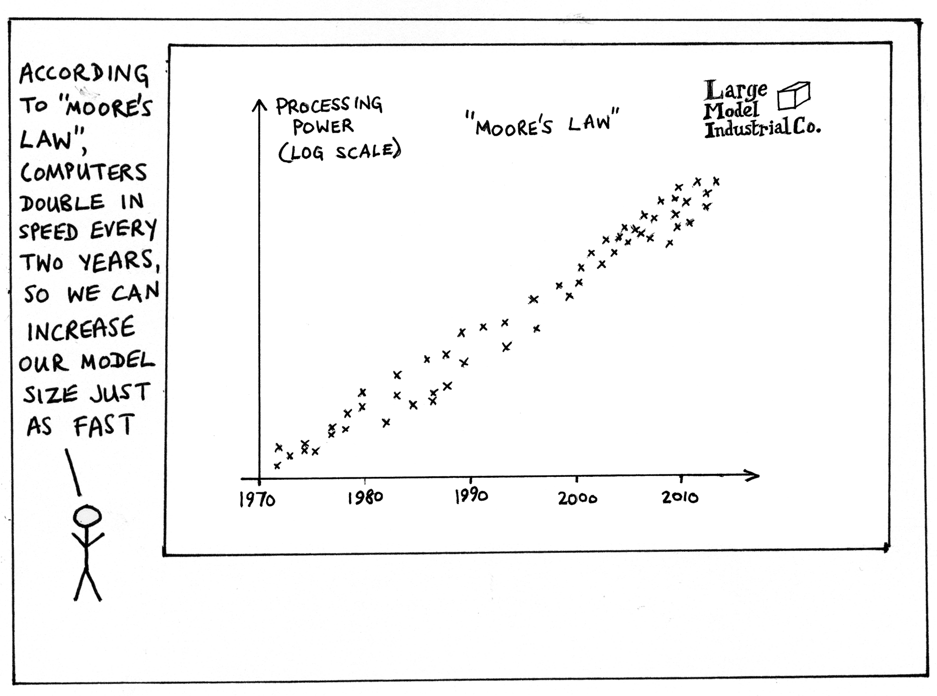
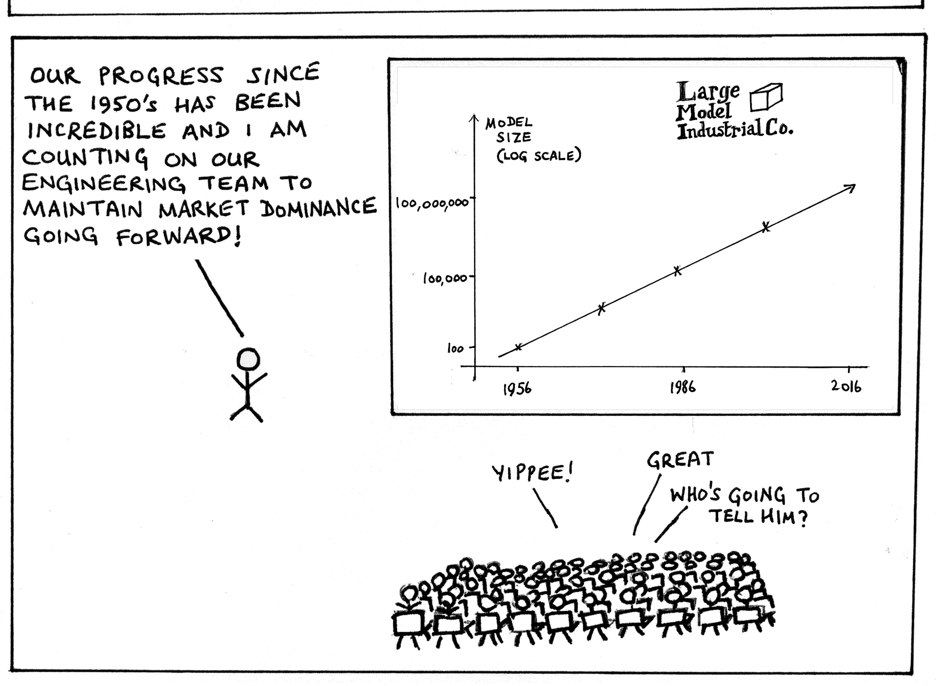
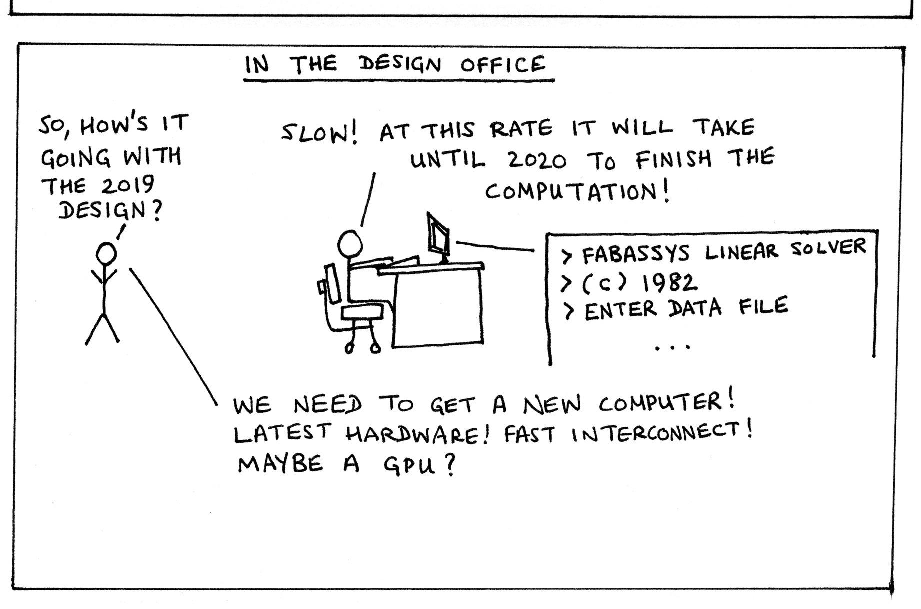
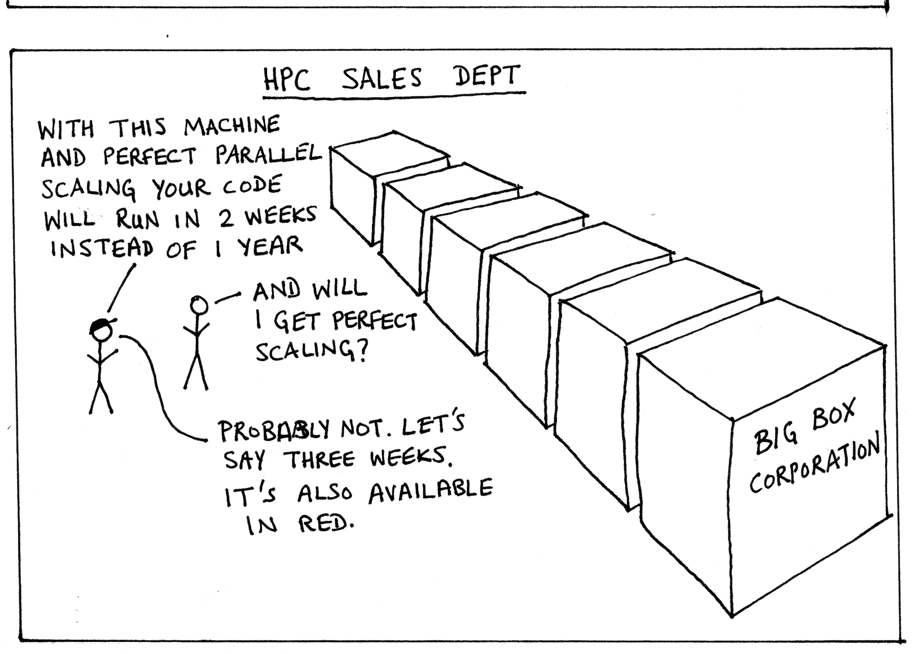
With apologies to stick-people everywhere... Any resemblances to actual persons or reality is purely coincidental.

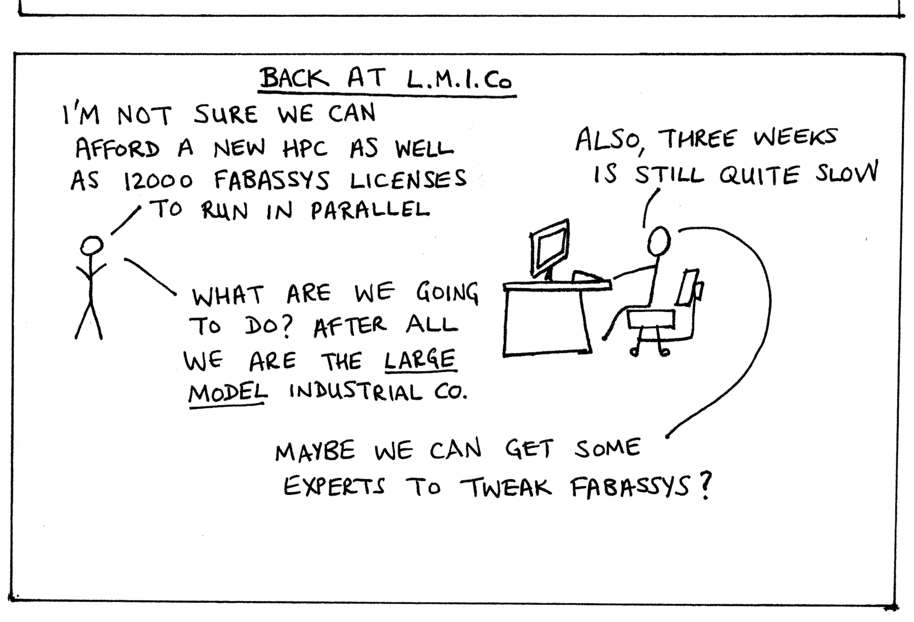


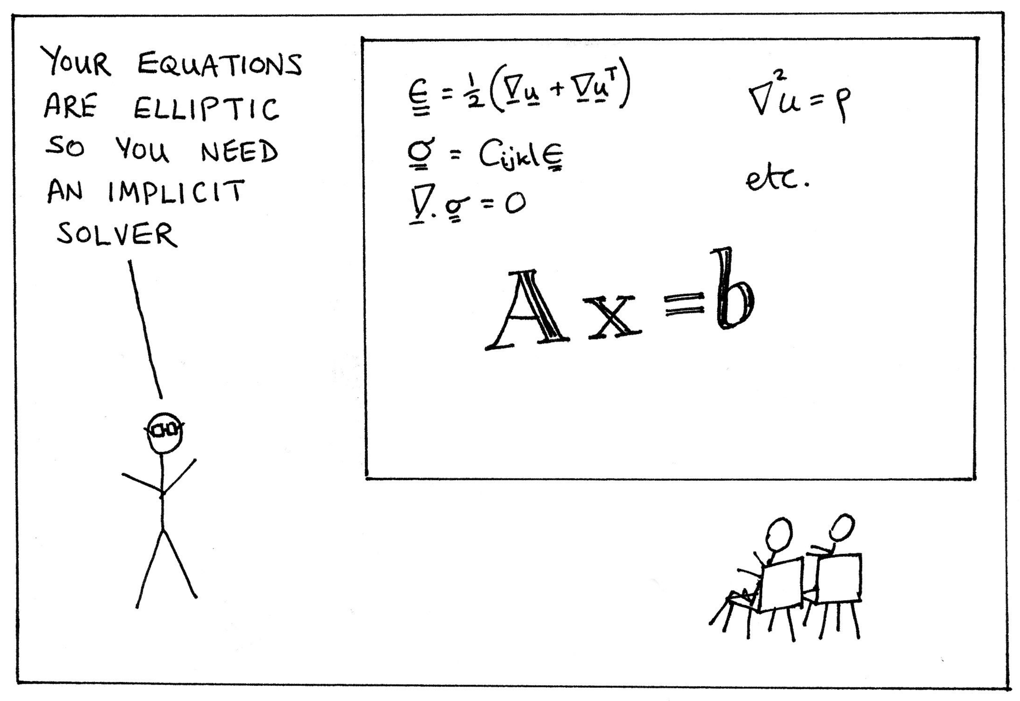


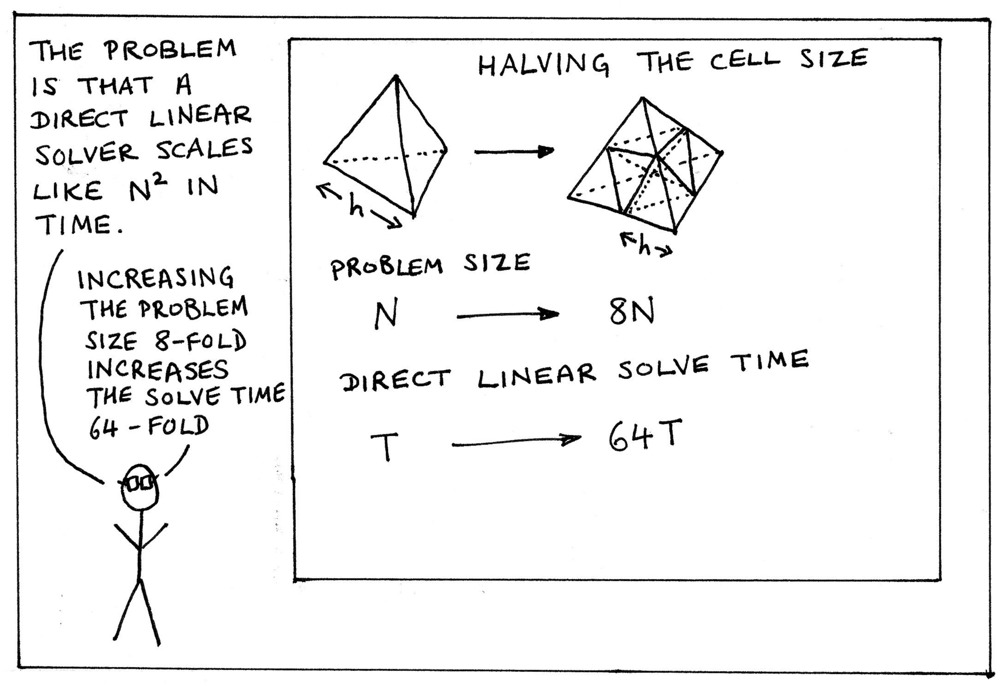


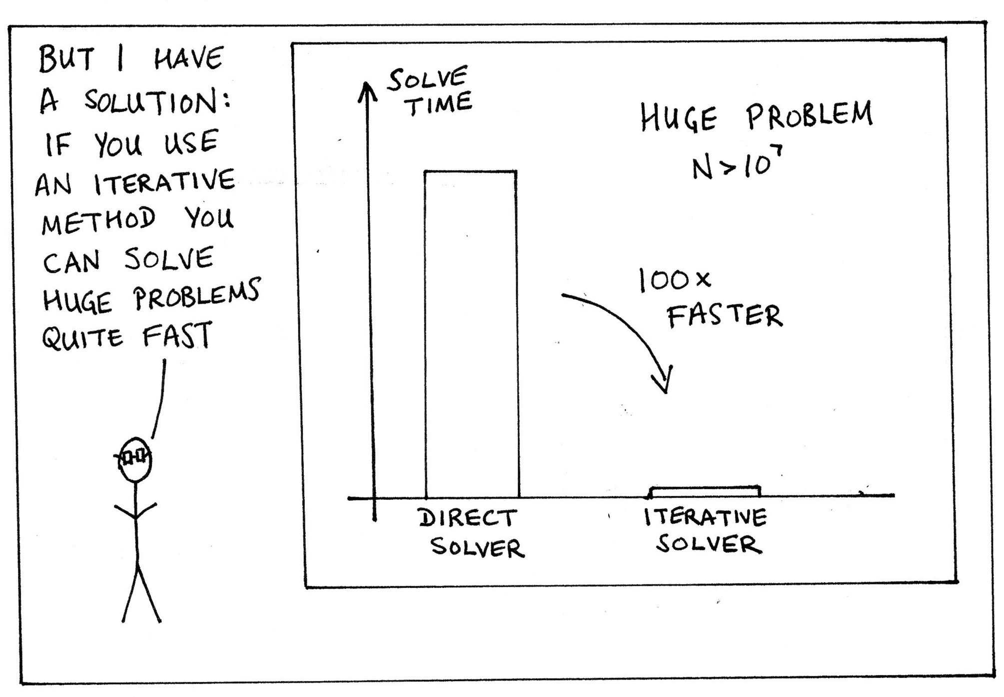


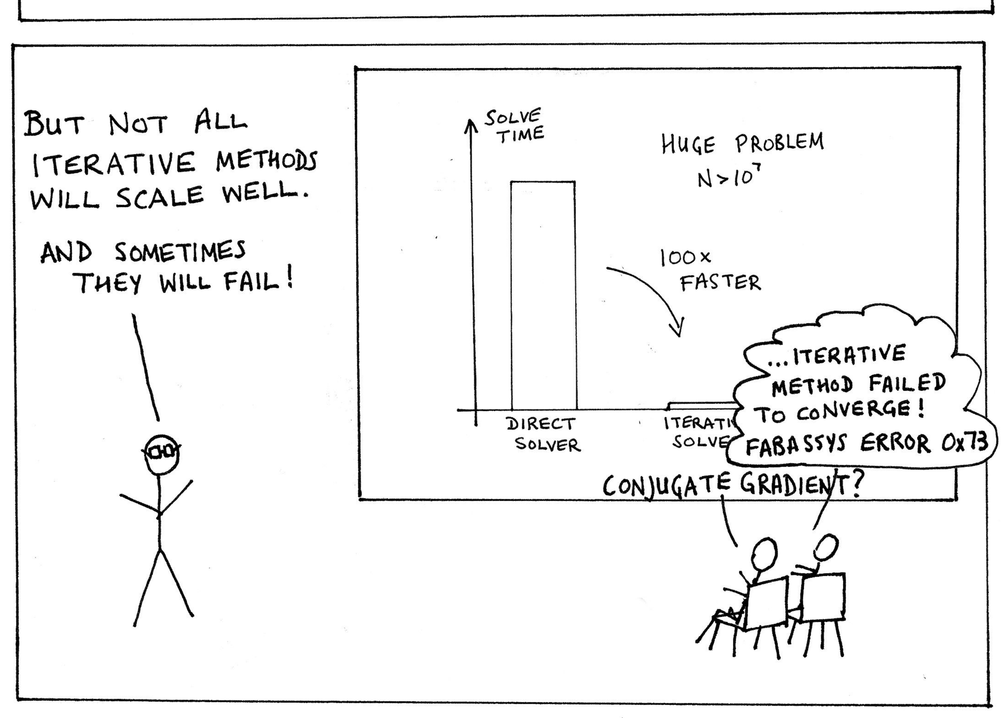


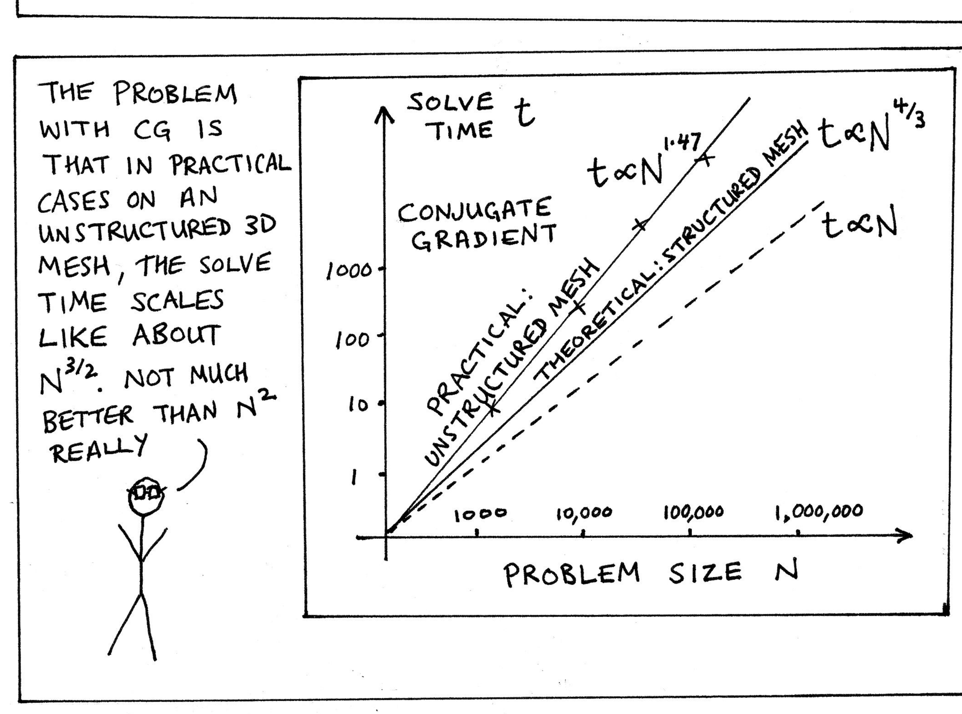


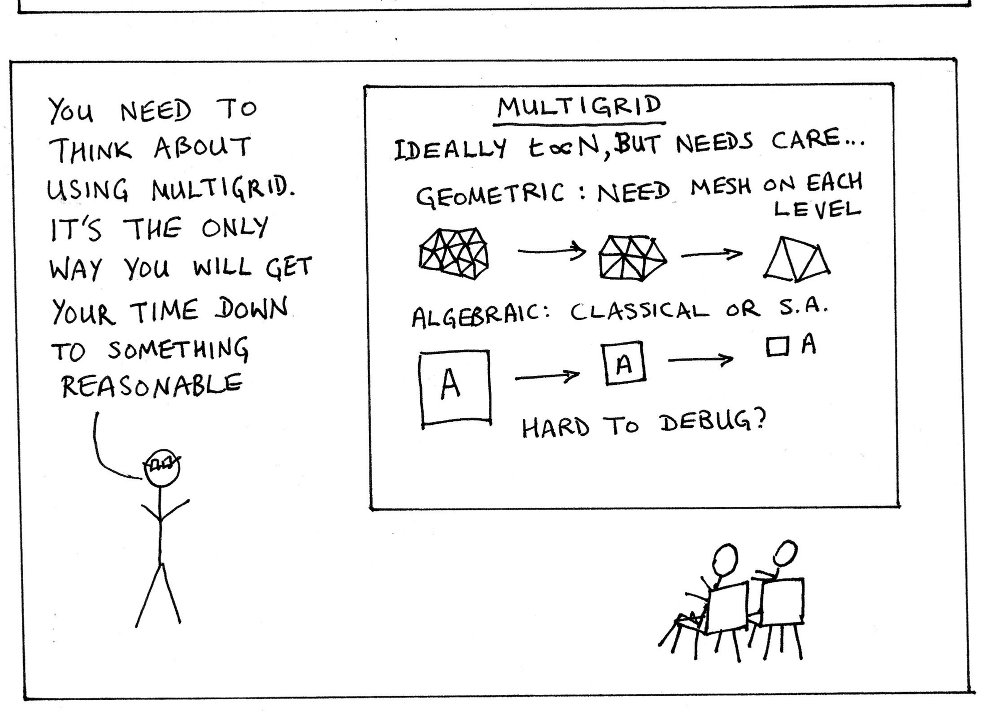


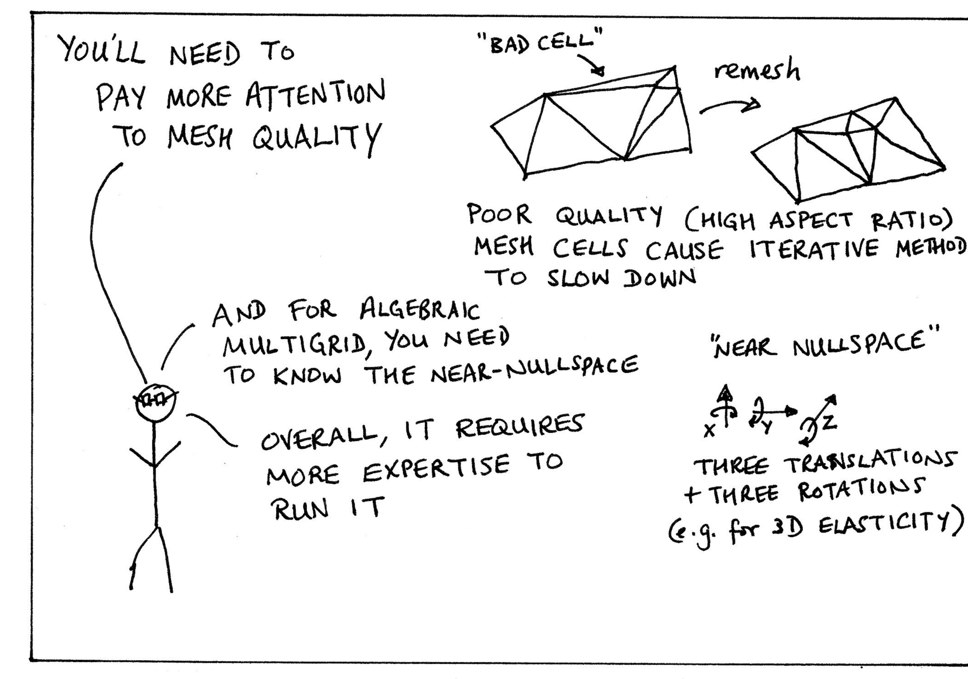


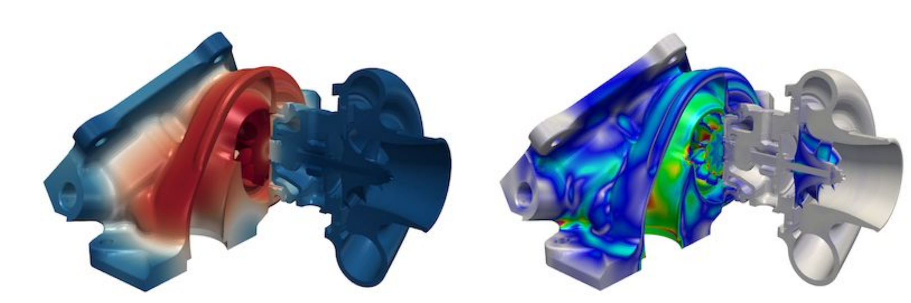




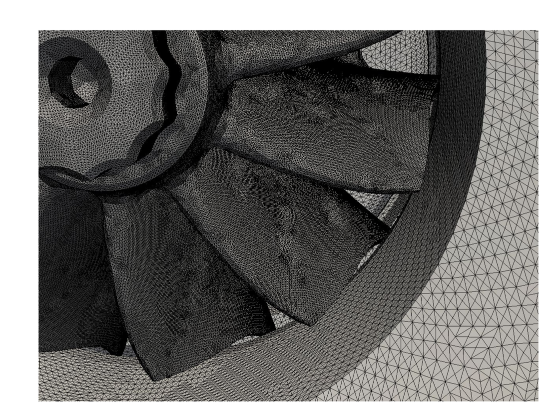




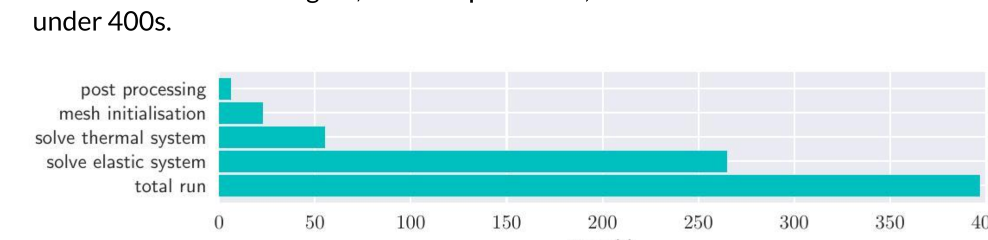




FEniCS PROJECT



Thermomechanical calculations with AMG using the FEniCS open source finite element package. The mesh has 820,960,256 cells and 163,283,303 vertices. 1,121,793,507 thermal degrees of freedom, and 3,365,380,521 elastic. The simulation was run using 24,576 MPI processes, and the time-to-solution was under 400s.



"Changing a mindset" by demonstrating:

★ A significant (10x, 100x) performance boost. Nobody will change their workflow for a 10-20% improvement.

★ Parallel computation alone cannot beat $O(N^2)$. We really need $O(N)$ methods.

★ Work on "real-world" problems. Theoretical gains on well-structured "cubes" often disappear in practice, and will not be believed.

★ Emphasis on building up expertise in new areas, e.g. in this case: mesh quality vs mesh size.

Richardson, C., Sime, N., & Wells, G. (2019). Scalable computation of thermomechanical turbomachinery problems. *Finite Elements in Analysis and Design, 155* 32-42. https://doi.org/10.1016/j.finel.2018.11.002