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Title: Development of a robust computational design simulator for industrial deformation processes

•Research Objectives:

To develop a mathematically and computationally rigorous gradient-based optimization methodology for virtual materials process design that is based on quantified product quality and accounts for process targets and constraints including economic aspects.

•Approach:

- Selection of the sequence of processes and initial process parameter designs using knowledge based expert systems, microstructure evolution paths and/or ideal forming techniques
- Selection of the design variables (e.g. die parameterization)
- Interactive optimization environment
- Continuum multi-stage process sensitivity analysis consistent with the direct process model
- Assessment of automatic process optimization
- Reliability of the optimal design to physical and computational model errors

•Broader Impact:

Successful development will lead to a virtual process laboratory that will assist industry in reducing lead time for process development, in trimming the cost of an extensive experimental trial-and-error process development effort, in developing processes for tailored material properties and in increasing volume/time yield.

•Significant Results:

- Development of a general purpose continuum sensitivity method for the design of multi-stage industrial deformation processes
- Applications to process design for microstructure control using various constitutive models
- Deformation process design for porous materials