1. **Research Title:** Linking processing structure and properties through deep learning

2. **Individual Sponsor:**

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3. **Academic Area/Field and Education Level:** Related Engineering Degree, Materials Science & Engineering, Electrical Engineering, Computer Science, Applied Math, Statistics, Machine Learning (MS or PhD level)

4. **Objectives:** Create a robust microstructure latent space through generative models with links to processing and properties.

5. **Description:** Generative adversarial networks, among other deep learning methods, have shown impressive results creating "deep fakes", fake images that cannot be distinguished from real ones. These approaches involve constructing images from a latent space representation, found in the training process, which encodes realistic images in a low-dimensional compact, differentiable space. Deep fakes are interpolations in this space and are statistically equivalent to those in the training set, but are not in the training set, itself. We hypothesize that the latent space in a microstructure context, based on a properly trained model, could provide a roadmap of attainable, non-equilibrium microstructures, with linkages to processing and properties. This could open the possibility of control over microstructure by exploiting the latent space, including finding discontinuities in the latent space, determining whether it is simply connected or would contain 'holes' that would be inaccessible by conventional processing methods, validating simulation methods in terms of the true variability of their outputs, quantifying uncertainty, and detecting rare events. In principle, this would be material agnostic, but the initial primary interest would be structural metallic systems.

6. **Research Classification/Restrictions:** This research topic is unclassified basic research eligible for publication in the open literature. U.S. Citizens Students Only

7. **Eligible Research Institutions:** All DAGSI Institutions