# Honors Thesis Proposal

**Working Title:**

Evolution of MG AZ31 twin activation with strain: a machine learning study

**Project Purpose:**

Microstructural deformation of magnesium due to twinning is thought to activate differently with varied levels of applied strain. This study aims to investigate this phenomenon using machine learning techniques.

**Project Importance:**

Statistical models of twin formation do not include stain considerations beyond strain hardening laws and twin saturation. This study aims to further inform the community on other attributes which depend on strain that should be taken into consideration in future models.

**Project Overview:**

Magnesium is a highly desired metal for transportation applications. It is a promising alternative to conventional steels because of its high strength to weight ratio. A major downside limiting its application is the costly manufacturing processes to shape the material. Deformation is difficult due to limited activation of deformation slip systems. In general, 5 active slip systems are required for accommodating deformation. At room temperatures, there is a lack of active slip systems in magnesium. Twinning is an additional deformation mechanism that can be activated in the absence of 5 active slip systems. The materials science community has devoted years of research to understanding the twinning phenomenon, creating various statistics based models to describe this supposed stochastic event.

In the past, these models have investigated hypotheses concerning attributes and their connections to twinning. Due to the sheer volume of possible hypotheses, knowledge generation about this vital deformation mechanism has been slow and limited. Machine learning has the promising ability to conduct hypothesis generation based on immensely complex datasets. Research was completed to suggest the possibility of using machine learning in such an application. That study investigated deformation twinning in magnesium alloy AZ31, a common alloy of magnesium. [1] The research suggested that machine learning can successfully uncover correlations between twinning and microstructure characteristics.

This study aims to expand the work completed previously. A dataset comprised of observed twin activity will be analyzed with a machine learning framework. Decision tree algorithms will be used to create models defining twinning in Mg AZ31 at 3 increasing strain levels. The decision trees will be compared and relationships between twinning and the attributes supplied will be extracted. Relationships extracted will be contrasted with knowledge available in literature, and any new relationships will be published in an effort to provide new insights to the community. The data for this project was collected previously as part of an NSF grant.

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[1] A.D. Orme, I. Chelladurai, T.M. Rampton, D.T. Fullwood, A. Khosravani, M.P. Miles, R.K. Mishra, Insights into twinning in Mg AZ31: A combined EBSD and machine learning study, Comp Mater Sci 124 (2016) 353-363

**Thesis Committee:**

Faculty Advisor: Dr. David Fullwood – Dr. Fullwood has been my faculty mentor for several years. I've conduced previous NSF grant research work with him. He is well known for his research in this particular area of magnesium deformation.

Faculty Reader: Dr. Michael Miles – Dr. Miles has worked with me on previous magnesium projects. His expertise will be vital in assuring the accuracy of the claims made in the final report.

Department Honors Coordinator: Dr. Brian Jensen – Dr. Jensen is the Coordinator for the Mechanical Engineering program.

**Project Timeline: (Pending Proposal Approval)**

Draft thesis –July 16th 2017
Revision of thesis – July 28th 2017
Defend thesis by August 25th 2017

**Funding:**

This project is fully funded under a National Science Foundation grant received by Dr. Fullwood.

**Culminating Experience:**

This research will be prepared for publication with a materials science journal, to be selected upon completion of the thesis to ensure it reaches the appropriate audience. In addition, concepts from this research will likely be presented at the Utah Conference for Undergraduate Research in 2018.