I/UCRC Executive Summary - Project Synopsis	**Date**:

Center/Site: CANFSA/Colorado School of Mines

Tracking No.:33b-L: In-situ Studies of Strain Rate Effects on Phase Transformations and Microstructural Evolution in Multi-Principal Element Alloys	**Phone :** (469)222-3811	**E-mail : jaopley@mymail.mines.edu**

Center/Site Director: CANFSA/M. Kaufman /A. Clarke/ P. Collins	**Type: (New)**
Project Leader: John Copley	**Proposed Budget**: $240K

Project Description: Investigation of the deformation mechanisms and microstructural evolution in multi-principal element alloys (MPEAs) as a function of deformation pathway, processing and composition to formulate an alloy design methodology. Specifically, transformation and twinning induced plasticity (TRIP & TWIP) effects in MPEAs are the main focus of this study, as TRIP/TWIP effects result in high work hardening rates, staving off instability and resulting in increased strength and uniform elongation. These alloys present potential blast and crash resistance, due to high absorbed-energy, as well as increased formability due to high uniform elongation.

Experimental plan: Alloys of varying compositions will be mechanically tested in different microstructural states during quasi-static and dynamic deformation. Characterization of the samples will occur before, after and during deformation with state-of-the-art techniques to understand the dependencies of TRIP and TWIP effects on intrinsic and extrinsic factors. This understanding will be used to inform the design methodology by means of analytical and numerical methods.

Related work elsewhere: There is a dearth of literature on the effects of strain state and rate on the mechanical properties and deformation behavior of MPEAs. Some studies exist for the effects of a small range of tensile strain rates for MPEAs, but little literature explores large ranges of strain rate or other strain states.

How this project is different: This study will explore both larger rangers of strain rates and strain states than existing work, and will not constrain alloy design to high entropy alloys specifically, allowing for a larger design space.

Milestones for the current proposed year: Characterization of TRIP and TWIP effects in $Co_{55}Cr_5Ni_{40}$ and dependencies on strain-path, strain rate, temperature, prior processing and microstructure (2019). In-situ characterization of microstructural evolution during high rate deformation (2019). In-situ study of TRIP & TWIP effects by transmission electron microscopy (TEM) (2019).

Deliverables for the current proposed year: Model describing dependencies of TWIP and TRIP in $Co_{.55}Cr_{.05}Ni_{.40}$ as a function of deformation conditions, specifically compression, tension and high-rate deformation. Initial mechanical testing and in-situ and post-mortem characterization will be performed this year.

How the project may be transformative and/or benefit society: The high work hardening rates associated with TRIP/TWIP behavior allows for both increased formability and strength in an alloy, allowing for the potential development of blast resistant structures with designed deformation mechanisms.

Research areas of expertise needed for project success: Microstructural characterization by means of optical and electron microscopy, X-ray diffraction, quasi-static mechanical testing and thermo-mechanical at Mines, in-situ deformation studies at national user facilities, alloy design and material fabrication

Potential Member Company Benefits: TRIP/TWIP materials show promise for desirable strength/ductility combinations. This study will allow for better understanding of TRIP/RWIP behavior in lightweight non-ferrous alloys, leading to improved alloy design, manufacturability, and the potential for tailored microstructures and deformation mechanisms..

Progress to Date: Initial characterization of the $Co_{55}Cr_5Ni_{40}$ is underway. In-situ tests to measure transformation product as a function of deformation conditions (temperature, strain rate) will be completed in 2019.	
Estimated Start Date: Fall 2018	**Estimated Knowledge Transfer Date**: Spring 2022

The Executive Summary is used by corporate stakeholders in evaluating the value of their leveraged investment in the center and its projects. It also enables stakeholders to discuss and decide on the projects that provide value to their respective organizations. **Ideally, the tool is completed and shared in advance of IAB meetings to help enable rational decision making.**