SECS Senior Design
Available Projects – Fall 2020

Friction in Forging Dies

Project Sponsors: Sergey Golovashchenko, PhD (golovash@oakland.edu), Srecko Zdravkovic, Ali Alshara

The limited life of forging dies is one of the factors adding substantial cost to overall cost of forgings. Adhesion of the billet material to the surface of the forging tool as well as change of roughness of the surface of the forging tool due to its deterioration through the life of the tool lead to gradual change of friction conditions through the life of the tool. Friction conditions are affecting the distribution of strains in the forged product: typically, increase of friction due to roughening of the surface of the forging tool leads to the increase of strains, which might lead to initiation of cracks. Also, increased friction further accelerates the deterioration of the forging die. Capturing early stage of friction increase and performing preventive maintenance of the die should prevent potential splitting in forged products and extend the life of forging dies. The proposed new methodology, when fully developed, should also enable more realistic comparison of performance of different lubricants for production conditions. In addition, measuring realistic coefficients of friction in a production forging tool is expected to enable more accurate numerical simulation of the forging process, which is important for proper selection of billet material, die materials, surface coatings and lubricants.

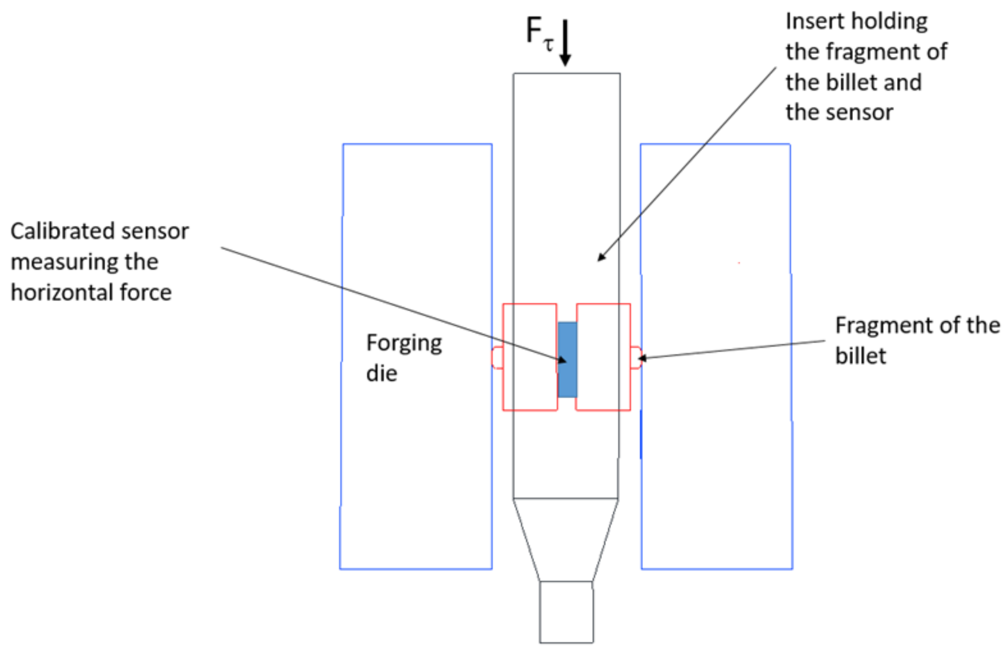
The objective of this project is to develop the methodology of measuring friction conditions in production cold forging dies and perform the initial early feasibility study for one forging die dedicated to forging of shafts. Due to budget limitations the measurements of coefficient of friction will be performed only for one forging die in its as-received condition. Replication of these measurements for similar dies periodically through their life cycle will potentially enable measurement of evolution of friction conditions through the life of multiple dies. The following deliverables are expected through the scope of the proposed microgrant project:

a) an experimental tool capable of measurement friction on the working surface of the forging die by applying measurable contact pressure between the fragment of the production billet and the die surface and measuring the force required for sliding of the billet fragment relative to the surface of the die;

b) experimental results on coefficient of friction measured as a function of contact pressure for the provided forging die.

We will use shaft forging dies from American Axle and Manufacturing for the initial validation of the proposed method. We will have two fully assembled inserts usable for this study.

Concept of testing surface condition of forging dies



NOTE:
This project will require significant time on campus during the Fall 2020 semester. If you are uncomfortable coming to campus, or have issue with any of the procedures or requirements of being on campus (https://oakland.edu/return-to-campus/), please do not select this project.

Small-Scale Functional Immersion Battery Cooling System

Project Sponsor: Sogefi Group - Steven Middaugh (steven.middaugh@sogefigroup.com)

The scope of this project is to design, build, and demonstrate a small-scale functional immersion battery cooling system. The system will consist of a battery module made up of three cell envelopes, appropriate plumbing and electrical connections, containment box/tank, cooling loop, and a battery state monitoring system that can provide temperatures, charge rate, and overall battery health. Sogefi will provide the battery module(s) to the student team.

The design group will be tasked to create submersible electrical connections at the battery tabs that are either sealed or do not react with the selected coolant medium. We also want the team to create a simple communications system that can monitor the battery parameters, turn the cooling loop on and off, and avoid battery degradation. The communication system should broadcast the information needed to keep the system's temperature regulated between 60°C – 90°C while charging and discharging the battery module. The containment box design is also up to the team to get creative with packaging. Since this is an automotive based system, think small, confined areas: hint – watch out for battery thermal expansion.

As with any real-world project, cost is a major factor in the overall design. We would like to see cost reduction ideas and lean implementations throughout the project pertaining to materials, manufacturability, labor, and R&D. Sogefi will be available for support in the areas of design, machine shop, and engineering.

For more information:
http://www.secs.oakland.edu/~latcha/ME4999/Sogefi%20Oakland%20Immersion%20Project.pdf

NOTES:
Non-disclosure and assignment agreements are required before students can begin work on this project.

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Afreecar E-Kit

Project sponsors: Christopher Borroni-Bird (chris@afreecar.org), Richard Saad (rich@afreecar.org)

Afreecar seeks to achieve its mission to provide sustainable power and mobility for all the world's people by providing a universal e-kit that can retrofit to an existing non-motorized vehicle to provide power assist, substitute an internal combustion engine (ICE) or power an all-new vehicle. The Afreecar e-kit includes the mechanical attachment, propulsion subsystem, electric power and mechanical power subsystem and computer/software subsystem. These subsystems are assembled to make an overall e-kit system.

The Afreecar e-kit is designed to be universal and flexible to meet the needs of all end-users, providing a customized solution with many different options. The user-selected performance requirements and vehicle type will inform an optimized configuration, capability, and specifications for the e-kit. This can include number and type of motors, batteries, solar panels, mechanical Power-Take-off (PTO), etc.

Afreecar has partnered with Altair, a global engineering and software company, in many different areas including brainstorming, design, simulation, software and physical prototypes. Afreecar was also sought out and funded by the Toyota Mobility Foundation (TMF) to collaborate on solutions to support economic development for the underserved in Sub-Saharan Africa. In March of 2020, Afreecar joined TMF in Zimbabwe and Kenya to evaluate broader opportunities for the Afreecar e-kit and for supporting several TMF pilots, including retrofitting mopeds and providing power assist for existing low-speed, non-motorized vehicles such as hand carts, tricycles, etc.

Afreecar also received, from Altair, two basic vehicles – a tricycle and an electric-powered wheelbarrow. CAD models of these two vehicles will be available. With the solar e-Cart, these vehicles will be available supporting an OU design project.

Afreecar would like to continue co-learning with OU SECS and the broader OU ecosystem using one or more of the three full-size prototype vehicles that could support our milestones. Per request for ideas on collaboration, please consider the following opportunities:

- Design, engineer, and fabricate a “universal” Afreecar e-kit that can physically integrate with two or more of the full-size physical properties; includes robust coupling of mechanical attachment, propulsion, electric power, mechanical Power Take-Off, vehicle control with smartphone, etc.
- Test solar e-Cart use in one or more applications (urban farm, medical building, etc.) to validate Altair’s vehicle performance software simulation

More information can be seen here: http://www.secs.oakland.edu/~latcha/ME4999/OU%20-%20Afreecar%20Fall%20Semester%20Collaboration%20Context%20and%20Opportuities.pdf

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Golf Disc Performance

Project Sponsor: Dan DelVescovo, PhD (delvescovo@oakland.edu)

Disc Golf is a popular and fun sport. Disc manufacturers have developed a "flight ratings system," that is intended to describe the way that a disc will fly. However, the disc flight is significantly influenced by many factors, including plastic type, age, wear, even color (as dyes can affect plastic properties), making these flight ratings merely suggestions of what the user will experience.

This project will consist of the following:

- Design of a system capable of throwing golf discs (aka Frisbees) at varying speeds, angles, and rotation rates to test the flight characteristics of different disc wing profiles and disc weights.

- Development of a disc flight dynamics model that could predict the flight of the disc based on its aerodynamic properties, weight, shape, environmental conditions, etc. Optional wind tunnel testing would be highly desirable for this model development as it would inform the aerodynamic properties of a disc.

This is not necessarily a purely mechanical system. Many important functions can be accomplished through electronic controls more accurately, securely and with less cost.

The design will be validated through analysis and simulation. Except for the optional wind tunnel testing, there is no need for campus presence.

Design of a secure "Porch Admiral"

Project Sponsor: Michael Latcha (latcha@oakland.edu)

Theft of delivered packages is a major problem and has significantly increased as shoppers have been driven to order more things online due to the Covid-19 pandemic. The folks who steal delivered packages are called commonly called "porch pirates." This project will develop an anti-theft (admiral = enemy of pirates) device that will allow delivered packages to be secure until the recipient can retrieve them from their porch.

Characteristics of the Porch Admiral:

- Will allow a delivery person to secure a package in the Porch Admiral
- Will allow multiple packages to be secured, delivered at different times by different delivery persons
- Porch Admiral will keep the package(s) secure, clean and dry
- The user will open the Porch Admiral to retrieve the packages, resetting it for future deliveries

There are many attempts at anti-porch pirate systems available today. Students pursuing this project will

- survey existing similar products and critically evaluate them
- devise a system that incorporates the characteristics above along with addressing the shortcomings of currently available systems
- come up with a better name for the product

This is not necessarily a purely mechanical system. Many important functions can be accomplished through electronic controls more accurately, securely and with less cost.

The design will be validated through analysis and simulation. No physical prototype will be constructed and therefore there is no requirement for campus presence.

Design of a Pickup Bed Organizer

Project Sponsor: Michael Latcha (latcha@oakland.edu)

Pickup trucks are very popular and useful personal vehicles, even for people who do not regularly haul cargo or material. Even for those that do, the size and location of the pickup bed can often make it difficult to store, secure and retrieve items from the bed of the truck.

The purpose of this project is to develop an after-market accessory system that will allow a user to

- load items (grocery bags, toolboxes, etc.) into the bed of a pickup,
- easily move them to a specific location, such as against the sides or the tailgate,
- keep the items secure in that location during transport,
- easily move the items to the sides or rear for removal,
- and easily fold out of the way when not in use.

The system can tap into the vehicle's electrical system for power. Groups can design for a specific pickup model, or a particular class of vehicles. The system should be able to be used with pickups with open beds, covers and bed caps. Convenience and ease of use are significant considerations.

The design will be validated through analysis and simulation. No physical prototype will be constructed and therefore there is no requirement for campus presence.

Design of a Winding and Measuring System

Project sponsor: Paul Huch (phuch@oakland.edu)

A system is desired to wind a line (string, rope, chain, etc.) around a detachable spool, keep the winding level on the spool and accurately measure the length of the line that has been wound on the spool. Requirements of the system are

- Accommodate different sizes and widths of detachable spools
- Automatic level winding mechanism
- Counting system that measures the length of the line accurately even when the amount of line on the spool changes
- The entire system must be integrated into a compact single assembly

This is not necessarily a mechanical system. Most of these functions can be accomplished through electronic controls more accurately and with less cost.

The design will be validated through analysis and simulation. No physical prototype will be constructed and therefore there is no requirement for campus presence.