UNC CHARLOTTE
The WILLIAM STATES LEE COLLEGE *of* ENGINEERING

Senior Design Project Description

Company Name	*GKN ePowertrain*	**Date Submitted**	*4/27/2020*
Project Title	*Assembly Training Station – Phase 2* **(GKN_TRAIN2)**	**Planned Starting Semester**	Fall 2020

Personnel

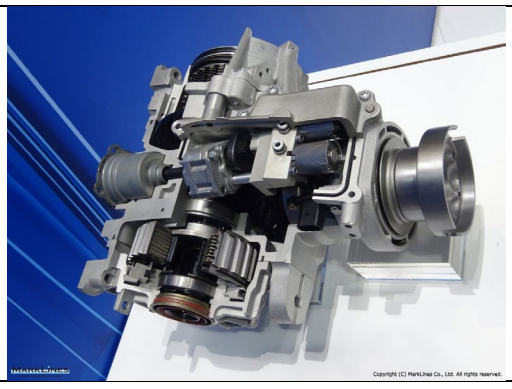
Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills:

Discipline	Number	Discipline	Number
Mechanical	3	Electrical	2
Computer	1	Systems	
Other ( )			

Company and Project Overview:

GKN ePowertrain, Newton is a leader in Tier 1 automotive differential assembly and component manufacturing. There are 2 plants on the Newton site. Plant 1 is the machining facility where differential ring and pinions are generated and manufactured. Plant 2 is the assembly plant. With 13 assembly lines and 4 major products it is a lean and diverse facility. The four main products that are manufactured are RDM (Rear Drive Module), FDU (Front Drive Unit), PTU (Power Transmission Unit), and Hydraulic disconnect clutches. With each of these units there are variants of clutch engagement and differential gear ratio, up to 18 variants per product, per customer. Some product examples:



With the 13 assembly lines in the plant, training of assembly operators is a cumbersome process. Many of the new employees have never seen an assembly line or functioned in an assembly environment. GKN needs to bring improved exposure to the training process, so a simulated assembly station is needed to ensure new employees understand and can interact with the basic job

requirements prior to starting work on the assembly line. A Fall 2019 project worked on Phase 1 of this project. Phase 2 will be to take that starting point and develop new scope and complete and demonstrate a functioning unit ready to train new workers.

Assembly Training Station – Team GKN_TRAIN_1 Status – End of Spring 2020 Semester

To slow the spread of COVID-19, Mecklenburg County and the state of North Carolina issued Stay-at-Home orders around mid-March, 2020. All classes and Labs were quickly moved to online only and access to the CAB Senior Design Lab was suspended. Additionally, all university machine shops were closed. Unfortunately, these actions completely halted build progress on the Training Station at a time when Team GKN_TRAIN was just starting full fabrication, assembly, and integration.

Instead of a fully functional Training Station to be exhibited at the May 1st Live Expo which was canceled, Team GKN_TRAIN_1 pivoted and focused on delivering a thorough Final Project Report package to document the starting point for Team GKN_TRAIN_2. This Report and associated files will have all the information necessary to complete a functional Training Station.

A detailed status of the Phase 1 Assembly Training Station follows:

- The Phase 1 Assembly Training Station implements the following GKN plant, FDU (Front Drive Unit) manufacturing steps (see Figure 1 below):
  - Torque Fill Plug with the Bosch Rexroth Nutrunner.
  - Press Tail Bearing Race with the 10 kN Kistler Servo Press.
  - Assemble Pinion, Head Bearing Race, Spacer, and Pinion Tail Bearing into front differential housing.
  - Disassemble front differential unit and prep station for next operator.

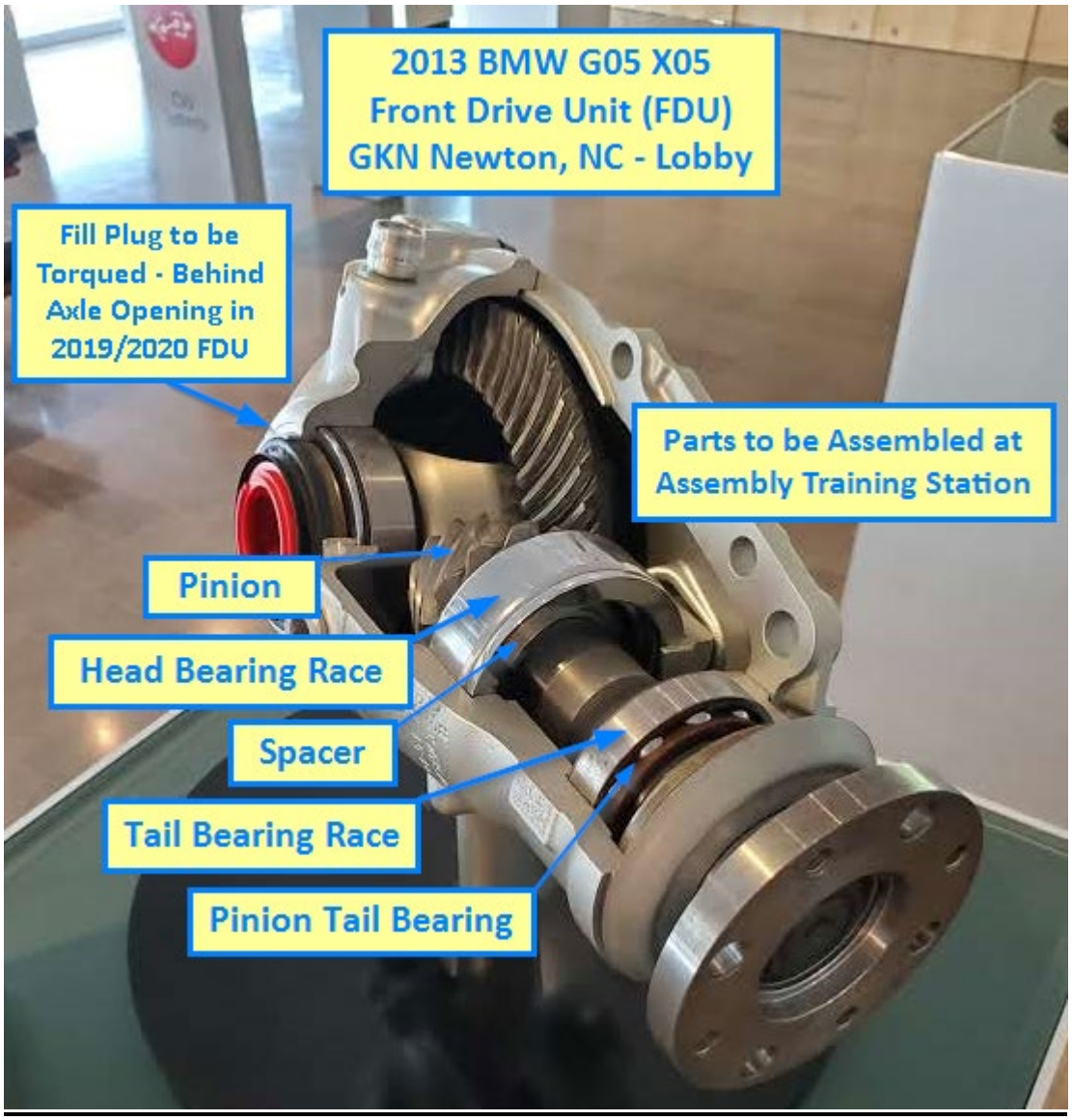


Figure 1 – Parts from the BMW G05 X05 Front Drive Unit to be Assembled at the Training Station

- The cage assembly, with its spring-dampening casters, tool & parts box, angled mounting plate for the Kistler 10 kN Servo Press, extruded aluminum frame members, and polycarbonate sides is 95% complete (see Figure 2 below).

- The 36”W x 48”H electrical/control panel has been received along with all of its major components. However, component mounting and wiring have not yet commenced. A detailed layout and wiring schematic will be part of the Final Project Report package.

- Leveraging a Siemens TIA Portal software startup session earlier in the semester with GKN Control Engineer, Scott Haver, the electrical/computer sub-team has a base control program ready to try on the Siemens PLC when integrated into a fully powered and assembled Training Station. Development was performed on two Dell laptops on loan from GKN’s Chris Taylor who installed the Siemens TIA Portal software and simulator for the electrical/computer sub-team.

- Though not yet fabricated, CAD designs for various mounting brackets (finger switch, light curtains, emergency stop switch, HMI display, and Nutrunner status display) are complete and were developed in PTC (Parametric Technology Corporation) Creo. Similarly, the four aluminum dowel pins to support the differential housing during the Tail Bearing Race press operation have been designed, but not yet fabricated. All of the CAD files will be provided as part of the Final Project Report package.

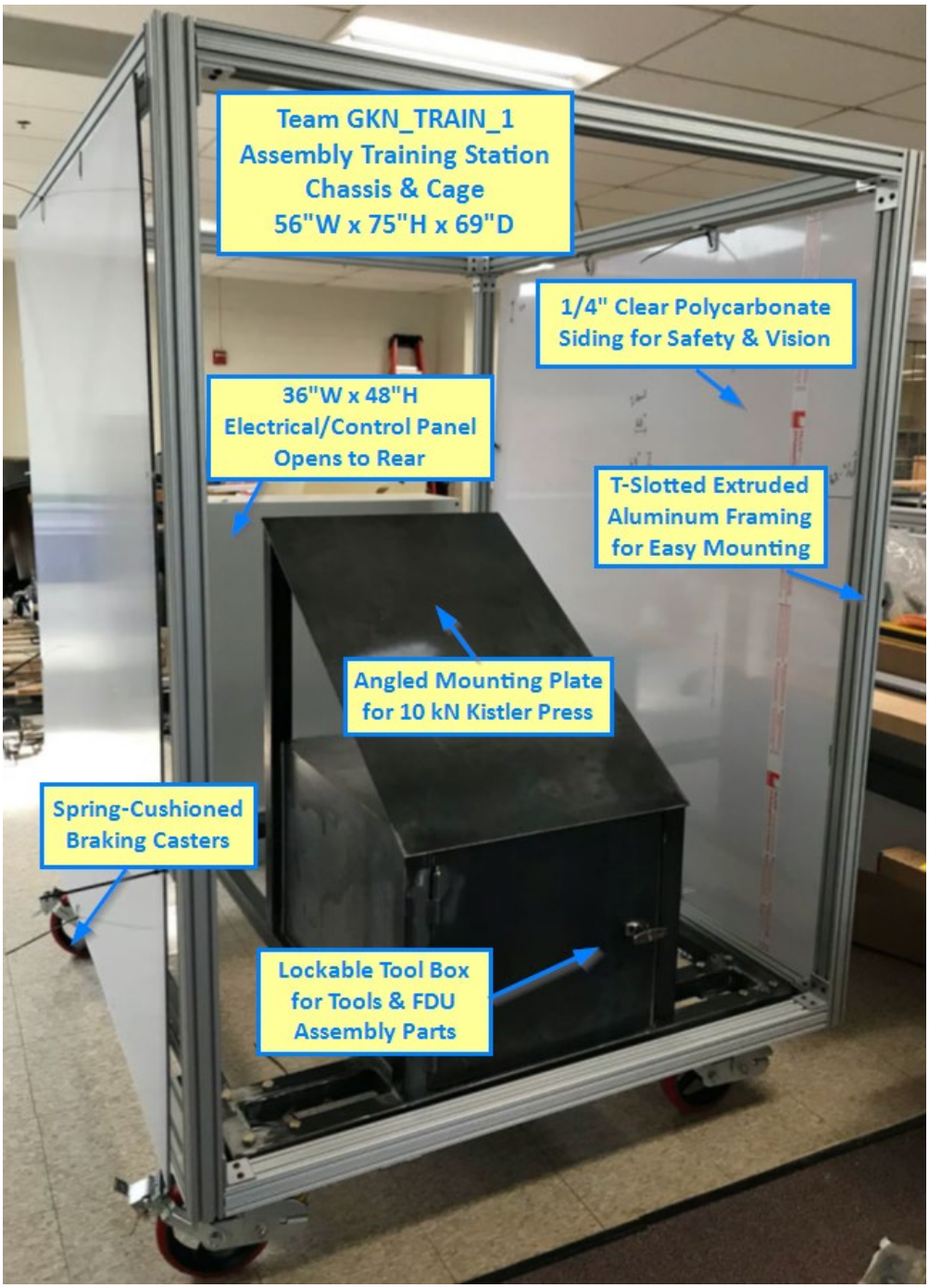


Figure 2 – Team GKN_TRAIN_1 – Partially Assembled Assembly Training Station

Project Requirements – Phase 1 & Phase 2:

Examples of actual assembly stations are shown below:

The simulated assembly station will not replicate an actual specific assembly station, it will be a station that new trainees can use to get exposure to typical characteristics found in real assembly workstations. The design of the assembly training station will be open to the creativity of the Senior design engineering team. The expectation is that the team spends time on the production floor to understand the assembly lines and the assembly processes. From that, GKN would like the senior design team to make recommendations to what functions should be included in the training station based on what they see as issues the operator would face from an experience and ergonomic perspective. Design priorities are: Safety first, quality second, operations third. Working with the assumption that a new employee has never worked in an assembly plant before, what should they know before they received specialized training at their work station? As students are not experienced assembly operators, they should be in a good position to understand the mindset of a new trainee.

The senior design team should take the feedback from GKN and develop a timeline to ensure that the timing fits into the window of the senior design project. GKN will assist in streamlining as necessary with long lead time items and specialty components that may be necessary.

There are some fundamental features like the safety devices that must be included, they are as follows: Light curtain, palm buttons, stack light, and lockout devices. Based on the team survey of plant operations, additional features can be agreed upon. As the team creates the plan to build and purchase the necessary components for the training station they will also have to put together the required work instructions, by the GKN standard template, so that new employees will be able to have a reference on how to operate the station and understand the risks involved with the station step by step.

As the components arrive, the team will have to construct the training station at the UNC Charlotte lab facilities. The students take total ownership and build the frame from the ground up considering mechanical design elements and electrical/computer attributes. Building the controls around the safety system to ensure no injury or accidents can occur is the key. With the support of the GKN, the expectation is a fully functional station that can been used to train and demonstrate the requirements of an operator in a controlled environment.

Additional Project Requirements (Proposed) – Phase 2 – Fall 2020 / Spring 2021

- Reexamine and redesign the fixturing and mock Tail Bearing Race required to implement the Tail Bearing Race press operation. Due to budget and time constraints, the current fixture design to hold the mock Tail Bearing Race to the actuator of the Kistler Press is a press-fit design. Over repeated actuations, though, the press-fit tolerances would likely open causing the friction attachment to fail and the fixture would fall off. With a full design semester a better approach would be a fixture that would hold the mock Tail Bearing Race in place and release it during the pressing operation. The mock Tail Bearing Race could be a machined-down version (dimensions to be designed) of the actual GKN part to enable a friction fit in the differential housing. This way, the press operation would not be a one and done operation and the mock Tail Bearing Race could be disassembled during the disassembly step and reused for the next training session.

- Reexamine and redesign the mounts needed to secure the light curtains to the cage. Long light curtains were supplied by GKN. However, shorter ones are available from GKN which would not interfere with the finger switch and emergency stop switch planned locations.

- For the Front Drive Unit (FDU) assembly operation, which was planned to be performed on a table adjacent to the Training Station, redesign the fixture that was to be used for the operation. The GKN_TRAIN_1 team planned on using left-over 11-gauge (1/8”) plate steel. However, a fixture designed from High Density Polyethylene Sheet (HDPE) plastic (a variety of thicknesses could be evaluated) would look and function better.

- To make the Assembly Training Station completely mobile and self-contained, select or design a table for the FDU assembly operation that could be hung on the side of the cage when not in use.

- Design a much more robust Siemens PLC interface environment. The current, un-debugged program provides just basic control. Add a complete, context-sensitive help module that would

display pictures and steps illustrating the current Training Station operation. In short, fully utilize the power of the Siemens PLC and the Human Machine Interface (HMI) and design it in such a way that the GKN control engineers could easily maintain and add to the program.

Expected Deliverables/Results:

- Functional assembly training station
- Design and build of the station
- Full Electrical and Mechanical print pack
- Complete parts list
- Electrically controlled station (if pneumatics is required, they must be stand alone with an included compressor)
- Safety controller integrated into the Siemens PLC system
- Including critical components from the assembly plant to ensure that new operators are comfortable and understand what they will be seeing and expected to utilize on a daily basis.
- Unit must be mobile, so it can be utilized in the GKN training center or on display at the facility.

Disposition of Deliverables at the End of the Project:

GKN will support the senior design project by ensuring that the station is portable and can be maneuvered between the UNC Charlotte campus and the training center at GKN Newton. This is intended to be a learning tool, so it can be shared as necessary. Unit will be demonstrated at the Expo, then transferred to GKN.

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If none please state none):

Drafting / CAD work will be required

Electrical controls and electrical systems

Ergonomics and Safety

Fabrication and assembly