

Innovating Standards Education: A Dual-University Model for Replicable Modules in Materials Processing and Machine Design

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Team Member

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Main Goals

- Create a systematic framework of lectures, labs, and project-based learning materials to strengthen standards education in the fields of **materials processing** and **machine design**.

Project Objectives

1. Develop innovative course modules (lecture, lab, and project) to use in current undergraduate curriculum to advance students' professional preparedness.
2. Develop Virtual Reality/Mixed Reality (VR/MR) learning materials to improve students' career readiness
3. Build a sustainable, online-accessible course structure to extend the educational impact and support long-term curriculum adoption.

Curriculum Development

- Course Modules
- Industry Seminars & Guest Lectures



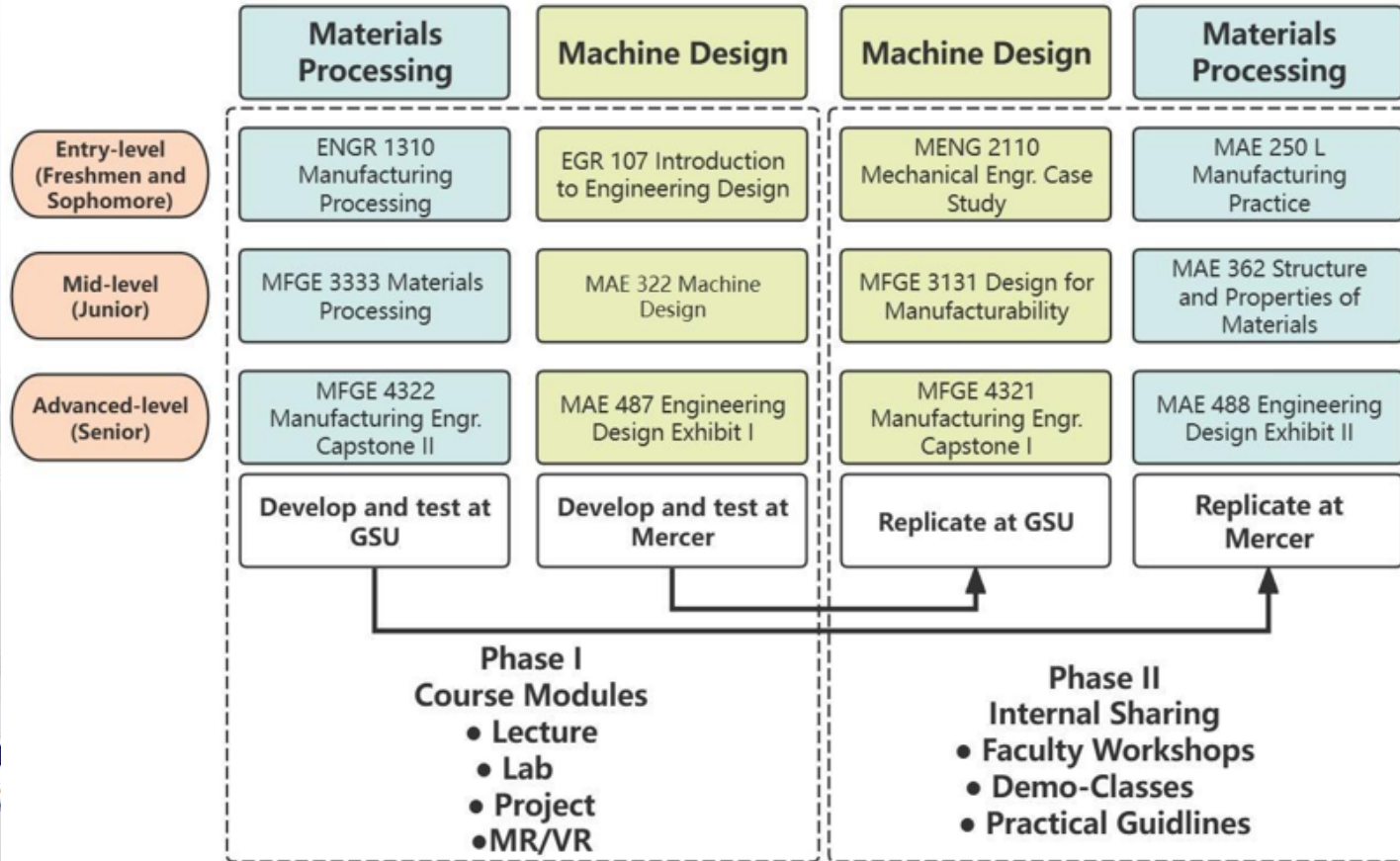
Course Modules

- Six standards-integrated course modules
- Two tracks: Materials Processing and Machine Design
- Three academic levels: Entry, Mid, and Advanced
- Integrated into 12 courses across GSU and Mercer

Course Modules

	Materials Processing (GSU)	Machine Design (Mercer)
Entry Level (<u>Freshmen and Sophomore</u>)	ENGR 1310 Manufacturing Engineering	EGR 107 Introduction to Engineering Design
Medium Level (<u>Junior</u>)	MFGE 3333 Materials Processing Studio	MAE 322 Machine Design
Graduate Level (<u>Senior</u>)	MFGE 4332 Manufacturing Engineering Capstone II	MAE 487 Engineering Design Exhibit I

Course Modules



Industry Seminars & Guest Lectures

- PAC members and SDOs



Replication

- Internal Sharing
- Class demos
- Project Website

Standards-Based Machine Design Module: Pilot Implementation

NIST SCO Curricula Development Cooperative Agreement • Pilot course: MAE 322 Machine Design, Mercer University, Spring 2026 • Team project: two-stage spur gear speed reducer for a warehouse belt conveyor

1 Standards applied by students

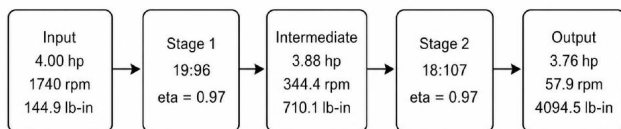
- ANSI/AGMA 2001-D04 — bending and pitting-resistance rating of spur gear teeth
- AGMA 908-B89 — geometry factors I (pitting) and J (bending)
- ANSI/ASME B17.1 — keys and keyseats: shear and bearing stress checks
- Manufacturer catalog data — C_{10} / C_0 ratings and L_{10} bearing life

2 Standards-driven constraints

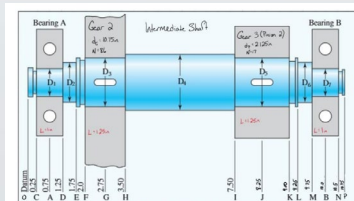
- 4 hp at 1740 rpm $\rightarrow \approx 58$ rpm, output torque $\geq 4,000$ lb-in, uniform load
- Diametral pitch selected from 6, 8, 10, 12; pressure angle = 20°
- Face width $3p \leq F \leq 5p$ and $F/d < 2$ per AGMA practice
- Hunting-tooth criterion: GCD = 1 in each mesh
- Bending and contact safety factors ≥ 1.5 ; 25,000 h service; 1×10^9 rev bearing life at R = 0.95

3 Module outcomes assessed

- (a) Use standards to define material properties and performance criteria — SLO 4
- (b) Apply standards-based methods to validate component performance — SLO 4, report rubric
- (c) Produce technical reports and drawings that adhere to standards — SLO 3
- Delivered as a four-person team design report, simulating a professional deliverable



 **GEORGIA SOUTHERN UNIVERSITY**
Power speed and torque flow with 97% mesh efficiency per stage (Team 1)



Pilot Results: Four Student Teams, One Standards Framework

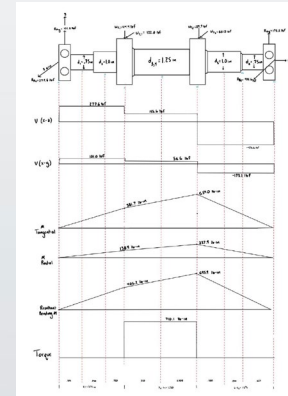
Every team independently applied ANSI/AGMA 2001-D04, ANSI B17.1 and catalog bearing-life data to the same specification: 4 hp, 1740 rpm $\rightarrow$ $\approx$ 58 rpm at $\geq$ 4,000 lb-in

Team	Diametral pitch and tooth counts (total ratio)	Output speed / torque	Gear material and heat treatment	Min. SF / SH	Bearings specified
Team 1	8 — 19:96, 18:107 (30.04:1)	57.9 rpm / 4,095 lb-in	Carburized AISI 8620, 58–62 HRC, case 0.020–0.030 in	3.22 / 1.81	SKF 6205, 6407, 6208 (deep-groove ball)
Team 2	8 — 16:97, 16:81 (30.69:1)	$\approx$ 58 rpm / 4,190 lb-in	AISI 1045 cold-drawn steel	2.22 / 1.84	IKO needle roller (deviates from spec)
Team 3	8 — 17:86, 17:101 (30.05:1)	57.9 rpm / 4,355 lb-in	AISI 1045, Grade 2 through-hardened, 350 HB	1.92 / 1.61	RLS 20 deep-groove ball, C = 13,601 lbf
Team 4	10 — 19:97, 21:127 (30.87:1)	56.4 rpm / 4,209 lb-in	Grade 2 through-hardened (St = 55 ksi) + carburized (Sc = 225 ksi)	2.61 / 2.09	NTN 30303 tapered roller (deviates from spec)



Assessment observations and planned module refinements

- All four teams satisfied the hunting-tooth criterion ($GCD = 1$ in both meshes) and met the bending and contact safety-factor targets of 1.5 using the AGMA 2001-D04 rating equations.
- The Stage-2 mesh governed in every design, and every team identified the intermediate shaft as the fatigue-critical member and sized it by combined bending and torsion.
- Depth of standard use varied: two teams applied the AGMA life and reliability factors (Y_n , Z_n , K_t , K_r); two used simplified allowables. The rubric will require explicit traceability of every rating factor to a clause or table.
- Two teams substituted needle or tapered roller bearings for the specified deep-groove ball bearings after a load-rating shortfall — a catalog-selection checkpoint will be added to the lab exercise.
- All teams specified real vendor components (SKF, NTN, IKO, McMaster-Carr), meeting the supplier-sourcing objective and the SLO 3 reporting deliverable.



Intermediate-shaft free-body, shear, bending-moment and torque diagrams supporting the fatigue sizing (Team 1)

Replicating a Learning Module: Best Practices from the Pilot

Carrying the standards module from MAE 322 Machine Design (Mercer) into MFGE 3131 Design for Manufacturability and Assembly (Georgia Southern)

1 Replicate one component interface, not the whole project

The gear-to-shaft joint is a single node of the reducer — rich enough to carry real design reasoning, small enough to scale from a one-month, four-person report down to a one-week individual homework.

2 Hand the replicating course verified data from the pilot

Intermediate-shaft torque (710 lb-in), shaft diameter (1.375 in) and the $3/8 \times 3/8 \times 1.5$ in key come straight from the MAE 322 reports, so student effort goes into the new decision rather than re-deriving loads.

3 Hold the standard constant; change the question asked of it

ANSI/ASME B17.1 stays the spine. MAE 322 asked “will the key carry the torque?”; MFGE 3131 asks “which joining method is easier and cheaper to machine, assemble and service?”

4 Re-map outcomes to the host course before writing the assignment

The same unified rubric is re-anchored from strength and fatigue verification to design trade-off reasoning, with one common assessment item retained so the two cohorts stay comparable.

5 Feed the pilot’s observed gaps into the replication

The Mercer findings — untraceable rating factors and off-specification catalog substitutions — become explicit requirements at GSU: cite the clause or table, and name real vendor part numbers.

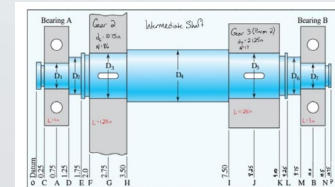


Potential example: the replicated homework

Specify the intermediate-shaft gear mount two ways — (A) a parallel square key per ANSI/ASME B17.1, and (B) set screws threaded through the hub onto a machined flat — then recommend one for production.

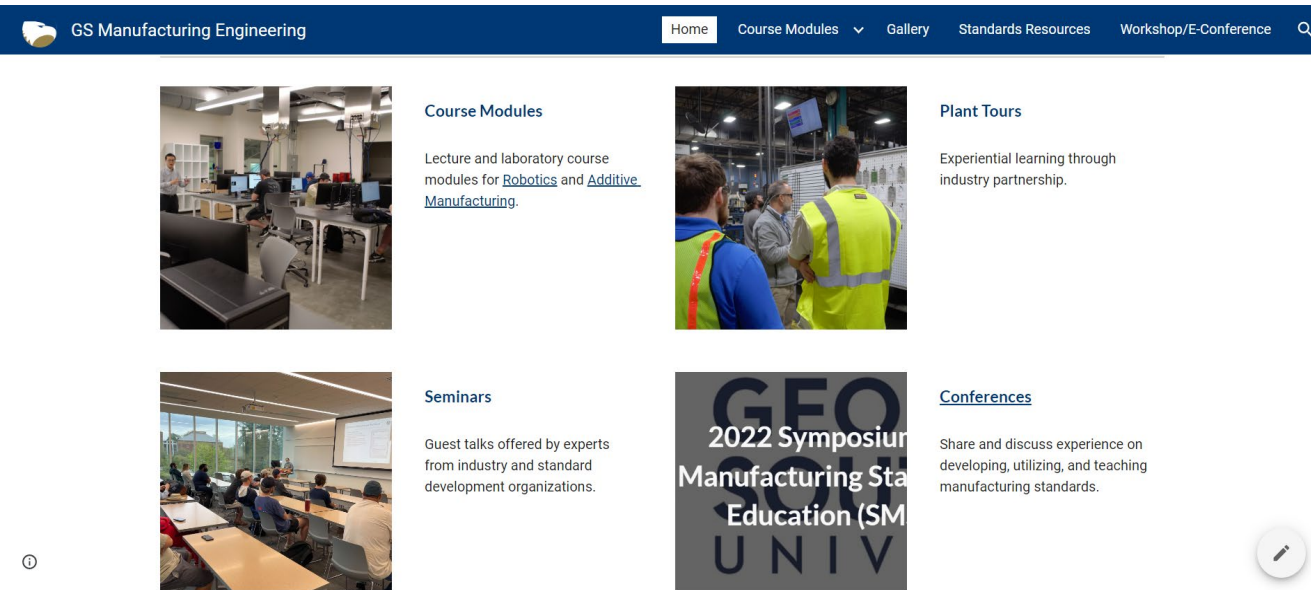
Students weigh:

- Torque capacity and slip under shock or reversing load
- Stress raisers: broached keyseat vs. milled flat on the shaft
- Machining and tooling: keyway broaching vs. drilling and tapping the hub
- Assembly time, access, angular and axial location
- Serviceability, re-use and field replacement
- Concentricity, balance and unit cost at volume



Source artifact: keyed gear and pinion mounts, pilot shaft (Team 3)

Project Website



- Download Course Modules
- E-conference Registration
- Videos records and pictures
- Student Resources
- Project news and updates



[Website Link](#)



Dissemination and Sharing

- Project Website
- Conference Presentations
- Workshops
- Professional Society

Conferences

- SoTL Commons Conference 2027 & 2028
- ASEE Southeastern Section Conference 2027



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Thank You!
Questions?



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