Capstone/Senior Design University Partnerships

Presented by:

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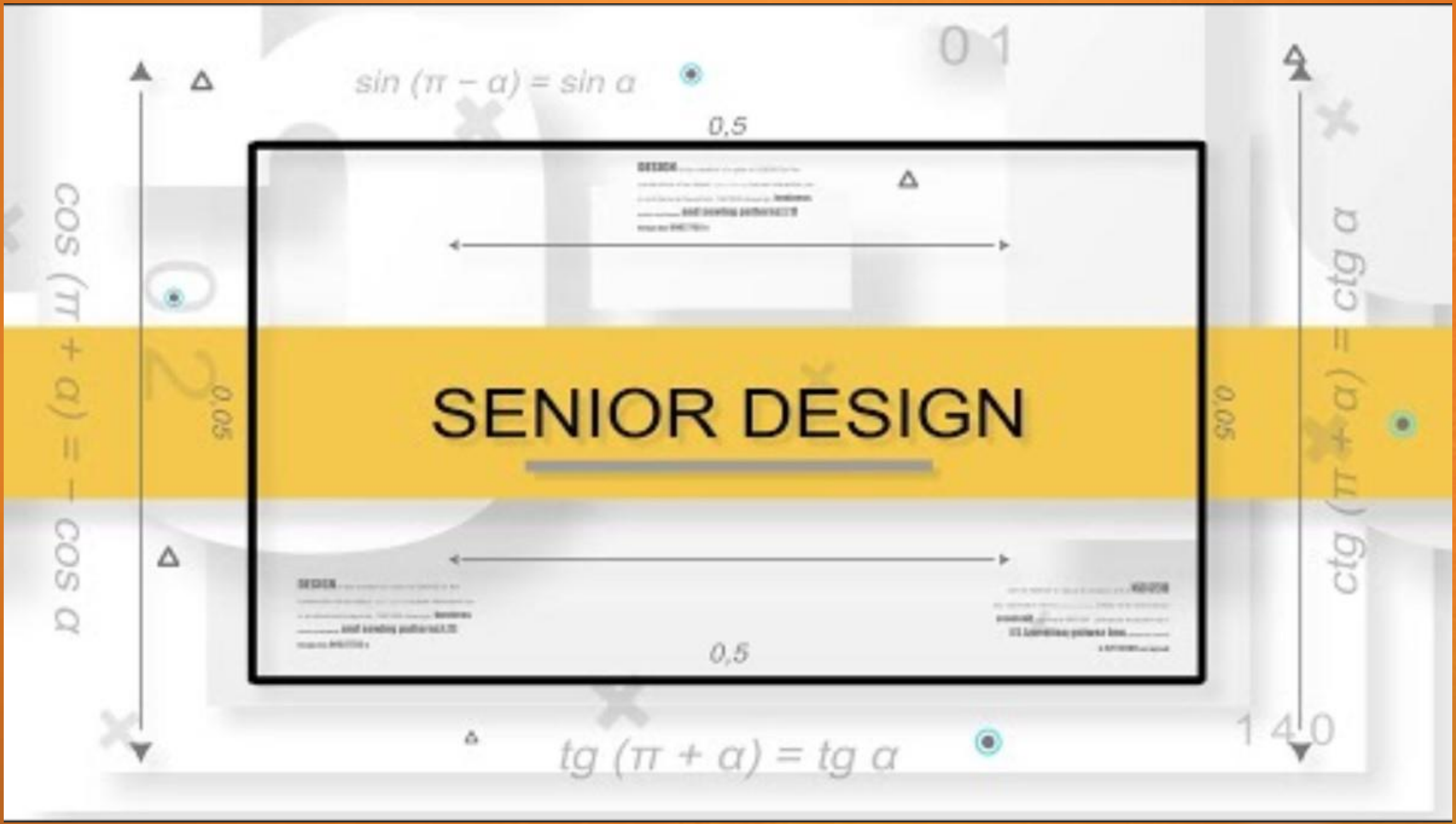
One Family. One Team.

Agenda

- What is a Capstone/Senior Design Project?
  - Video
- How did Charter Get involved?
- Examples of Projects and Results
  - Compression Testing
  - Anneal Cycle Optimization
  - Recruitment Aspect
- University Perspective
- Q&A
  - Questions are welcome throughout, please raise your hand!

What is a Capstone/Senior Design Project?



How did Charter Steel get involved?

Compression Testing Overview (R&D Advantage)

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Problem Statement

"There are limitations to tensile and reduction-of-area characterization of materials to be used in compression. Charter Steel would like to develop a test that will provide a quick and efficient means to characterize material through compressive measures."

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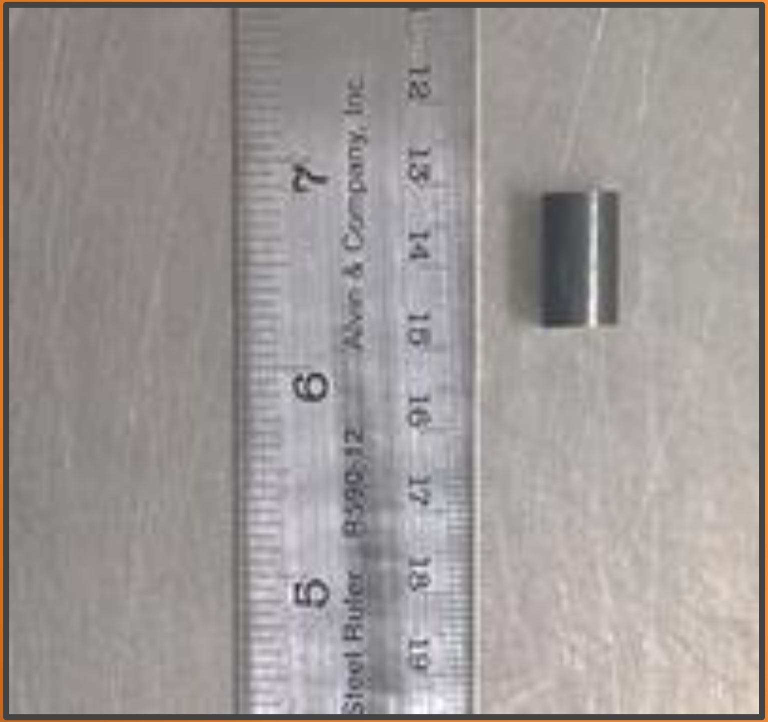
Experimental Work



Compressive Failures

- **An ASTM standard exists for compression testing**
  - **Lengthy process due to low strain rate**
  - **Selective and meticulous sample preparation**

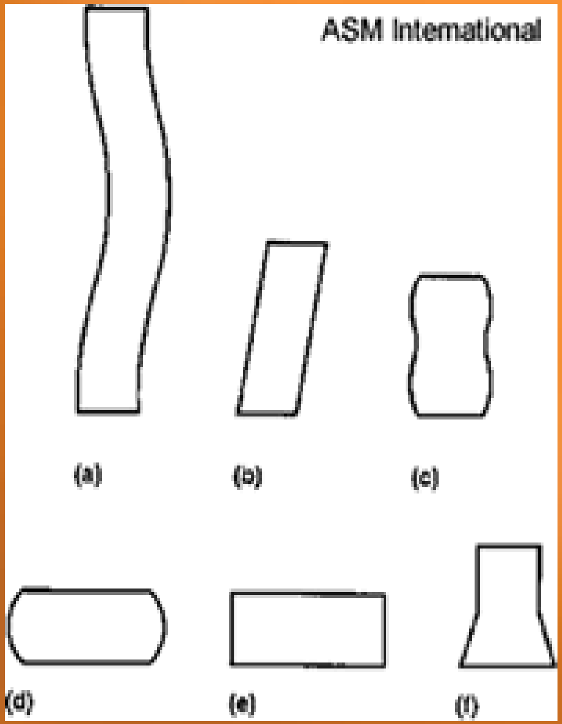
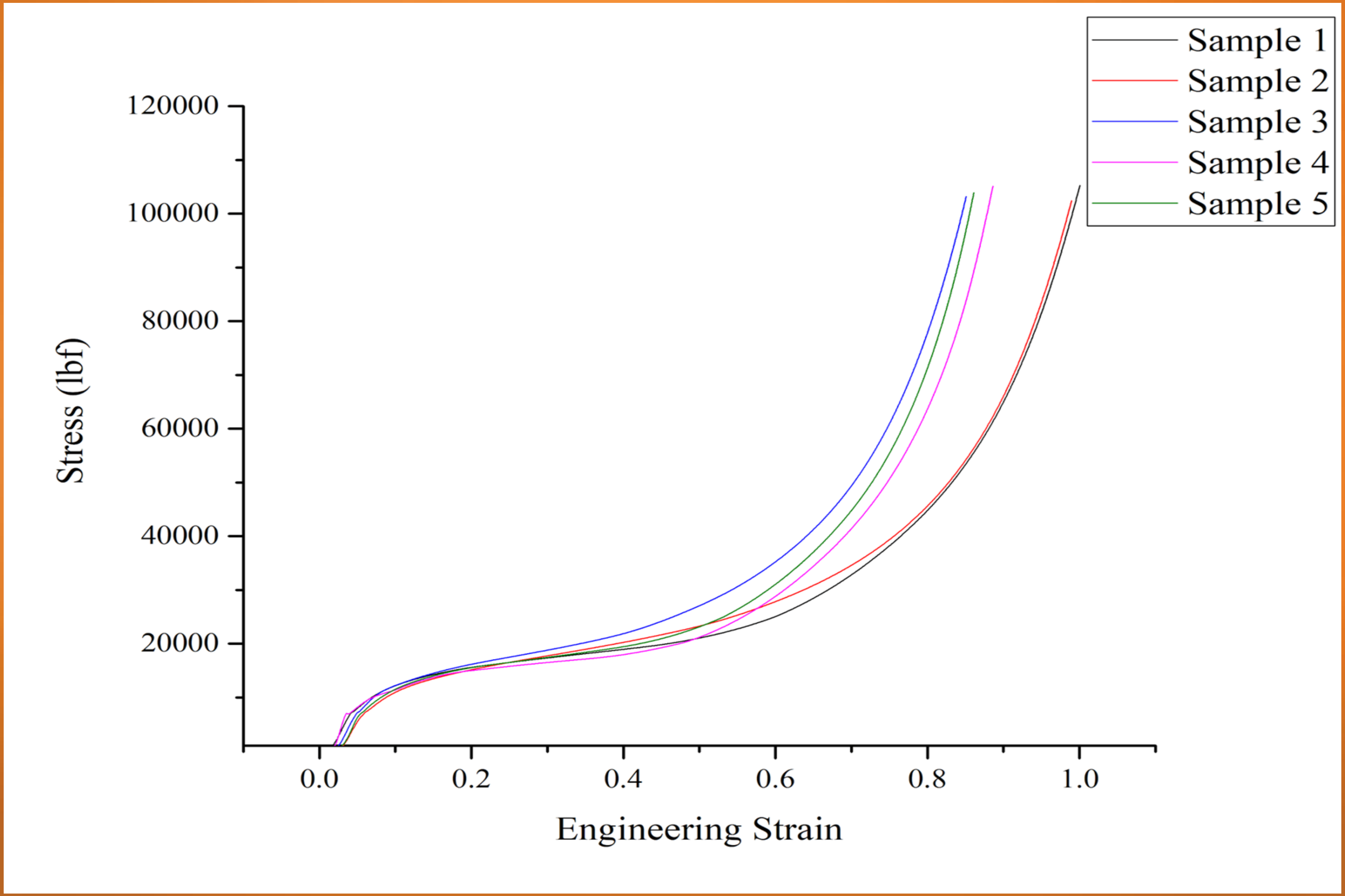


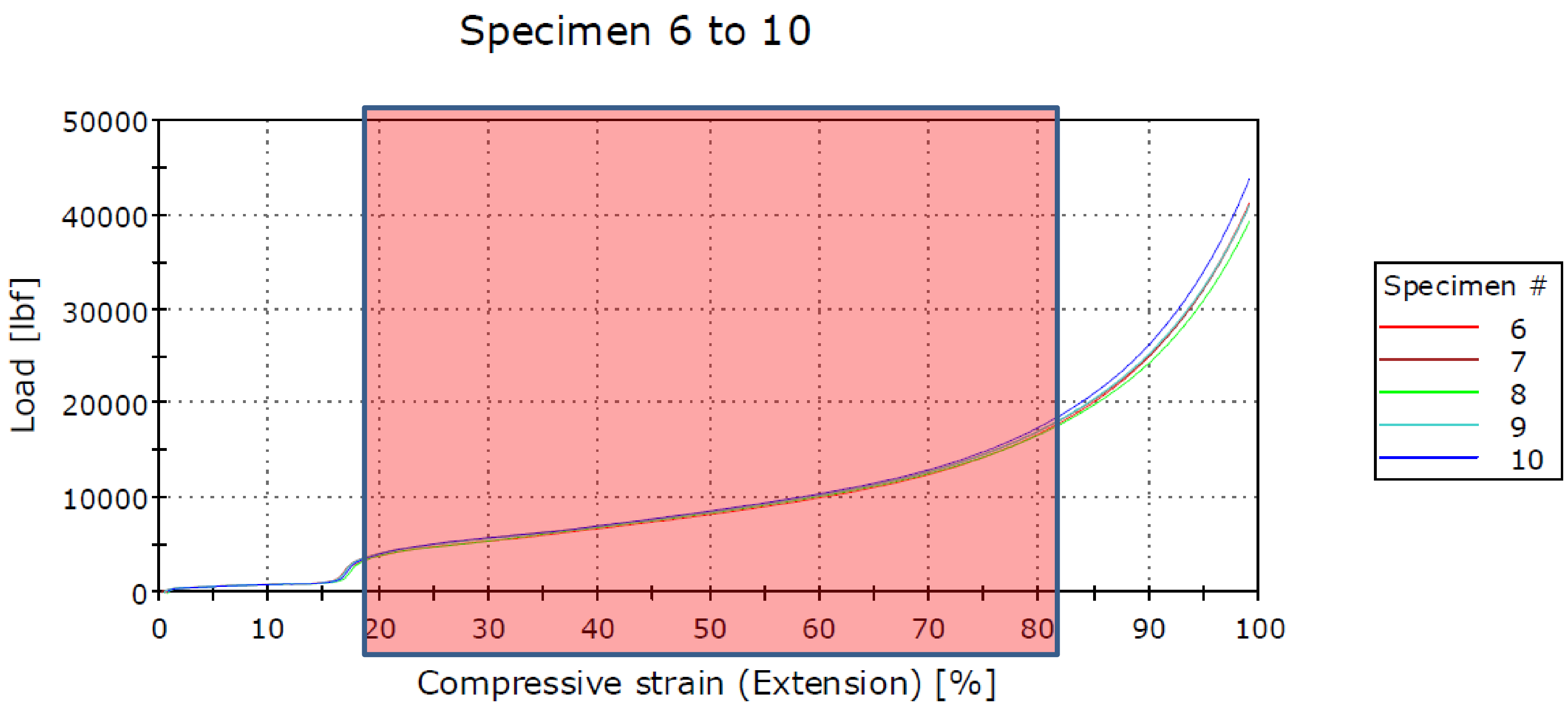
Fig 2. Different modes of failure under compression. a) Buckling, (b) shearing, (c) double barreling, (d) barreling, (e) homogenous compression, (f) compressive instability.

Experimental Work (cont.)

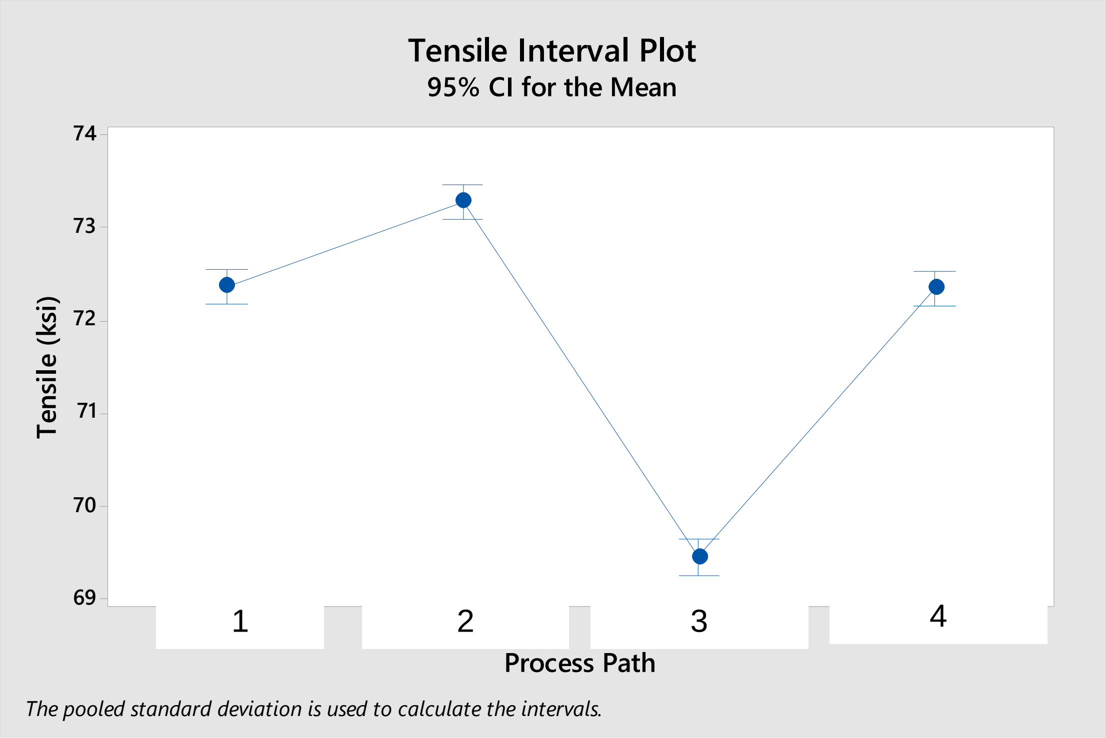


Compression Slugs

Area-Under-the-Curve



Tensile ANOVA



Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Process Path	3	200.11	66.7026	300.30	0.000
Error	92	20.43	0.2221		
Total	95	220.54			

Model Summary

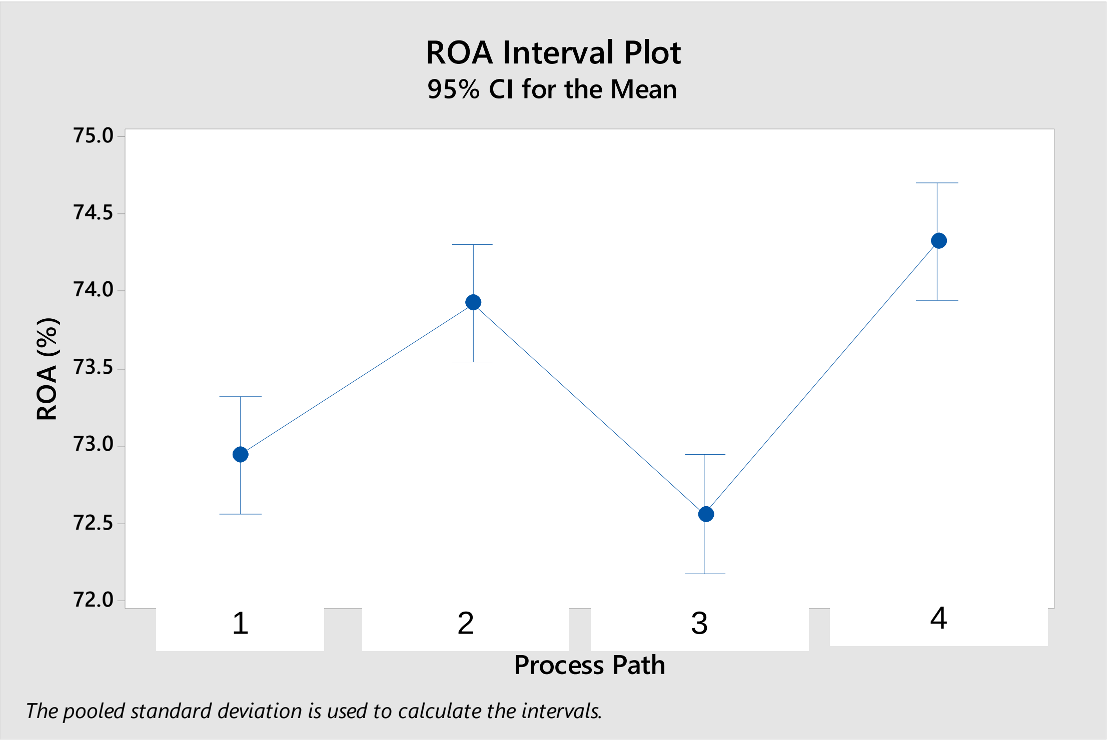
S	R-sq	R-sq(adj)	R-sq(pred)
0.471294	90.73%	90.43%	89.91%

Means

Process Path	N	Mean	StDev	95% CI
1	24	72.3778	0.3271	(72.1868, 72.5689)
2	24	73.290	0.537	(73.099, 73.481)
3	24	69.456	0.594	(69.265, 69.647)
4	24	72.3571	0.3748	(72.1661, 72.5482)

Pooled StDev = 0.471294

Reduction of Area ANOVA



Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Process Path	3	48.89	16.2953	18.23	0.000
Error	92	82.24	0.8939		
Total	95	131.12			

Model Summary

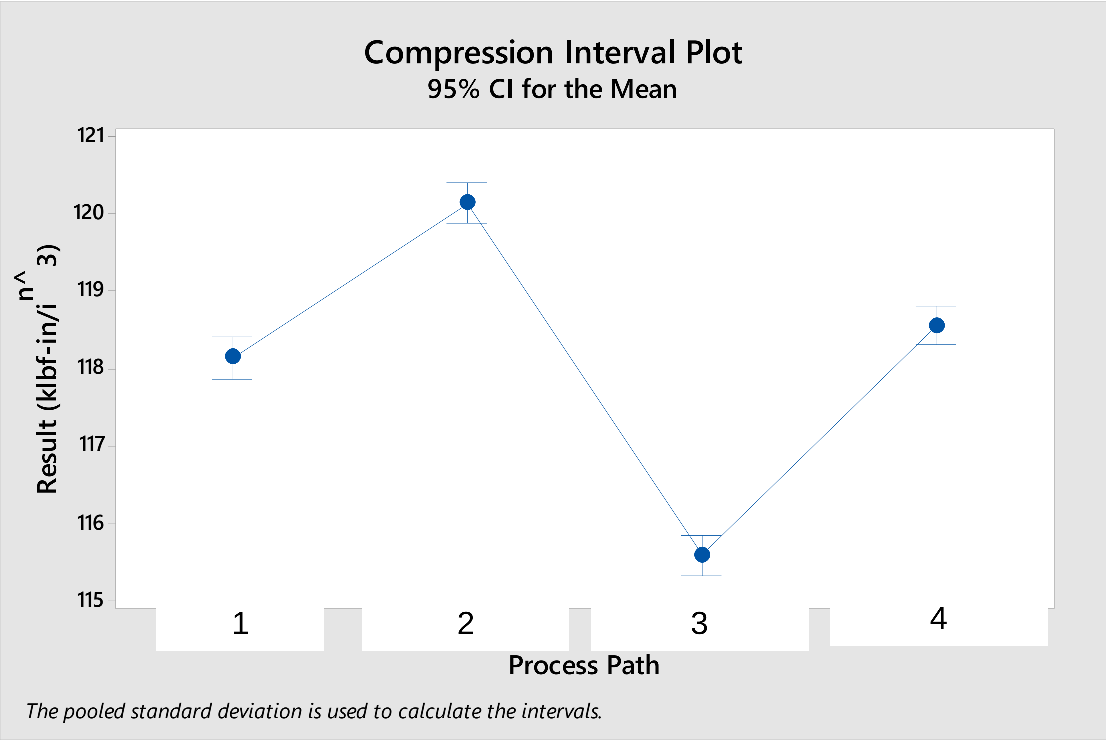
S	R-sq	R-sq(adj)	R-sq(pred)
0.945443	37.28%	35.24%	31.71%

Means

Process Path	N	Mean	StDev	95% CI
1	24	72.948	0.742	(72.565, 73.331)
2	24	73.929	0.750	(73.546, 74.312)
3	24	72.564	1.458	(72.180, 72.947)
4	24	74.328	0.581	(73.944, 74.711)

Pooled StDev = 0.945443

Compression ANOVA



Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Process Path	3	688.4	229.457	205.48	0.000
Error	257	287.0	1.117		
Total	260	975.4			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
1.05673	70.58%	70.23%	69.64%

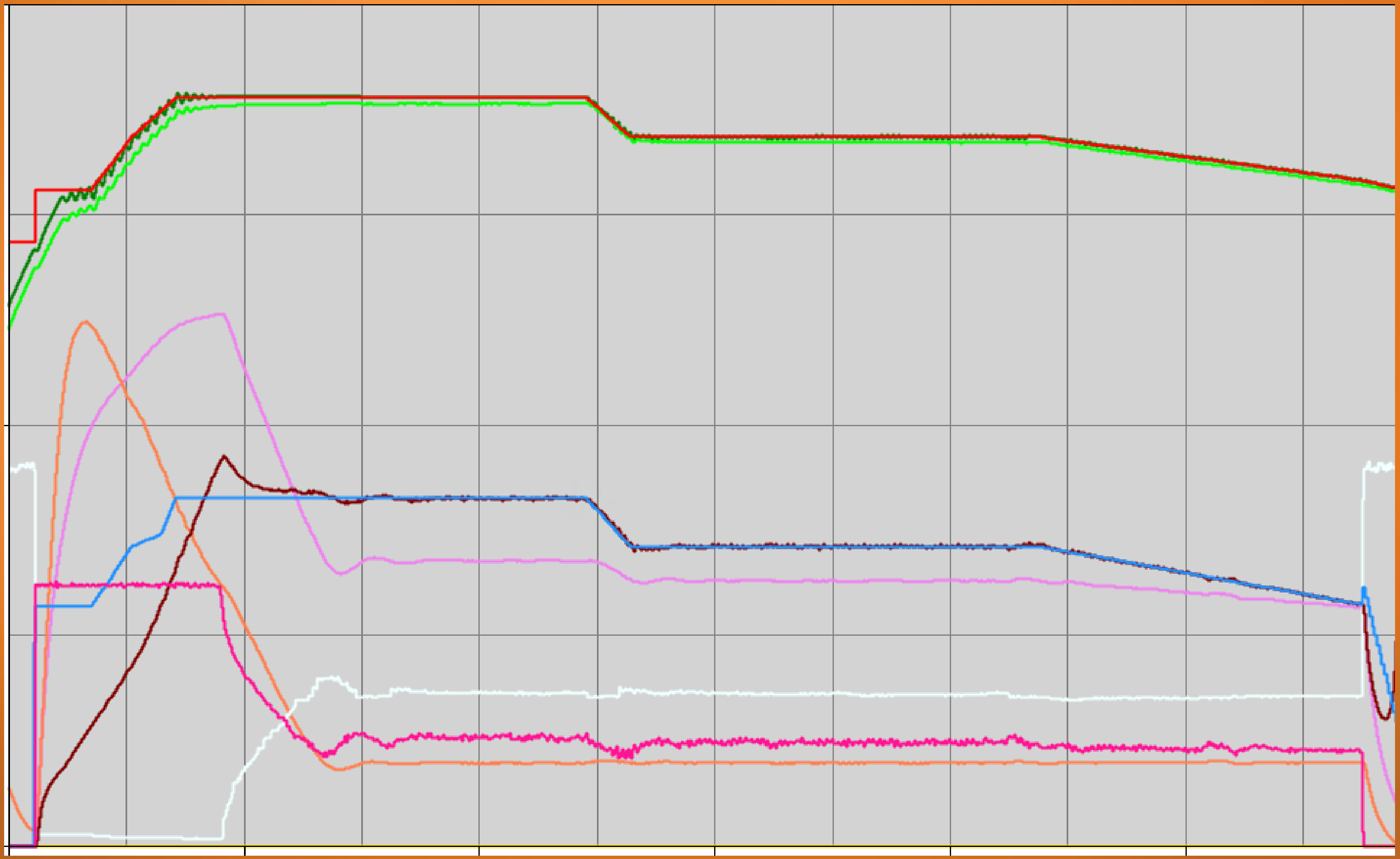
Means

Process Path	N	Mean	StDev	95% CI
1	61	118.151	1.098	(117.885, 118.417)
2	67	120.154	0.983	(119.899, 120.408)
3	63	115.608	1.364	(115.345, 115.870)
4	70	118.568	0.717	(118.319, 118.816)

Pooled StDev = 1.05673

Anneal Cycle Optimization

Cycle Times



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Heat Treatment

- Experimental trials
  - Decrease furnace temperature
  - Decrease furnace times
  - Intermediate Step

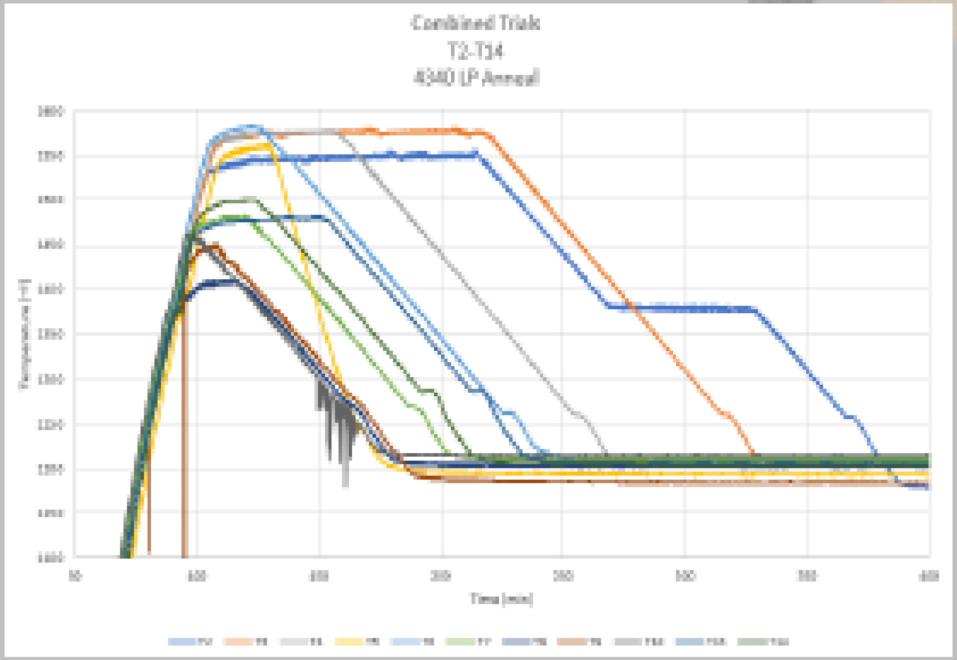


Figure 10: Heat treatment trials T2-T14.

Microscopy

- Transverse cross section
- All micros were taken at mid radius
- Etched with 4% Picral

Figure 16: Depiction of Image Location

Figure 17: Trial 3 - Decrease Hold time 85% LP

Figure 18: Trial 9 - Decrease Hold Time 30% LP

Figure 19: Trial 4 - Decrease Hold Time 80% LP

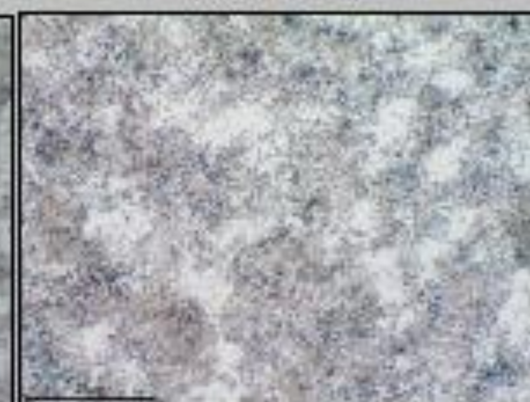


Figure 20: Trial 11 - Cooling Rate Increase 40% LP

Results

- Requirement: 80%
- Reduce in time
- Reduce temperature
- Combine reduction in time with temperature cautiously

Trial	Rating	Benefit
T1	80%	Reduce time
T2	85%	
T3	85%	
T4	80%	
T5	85%	
T6	60%	
T7	60%	Reduce temperature
T8	20%	
T9	30%	Reduce time at the reduced temperature
T10	30%	
T11	40%	
T12	60%	
T13	20%	Understand time
T14	40%	Understand temp

Table 3: Trials with respective ratings from Charter Steel

Results

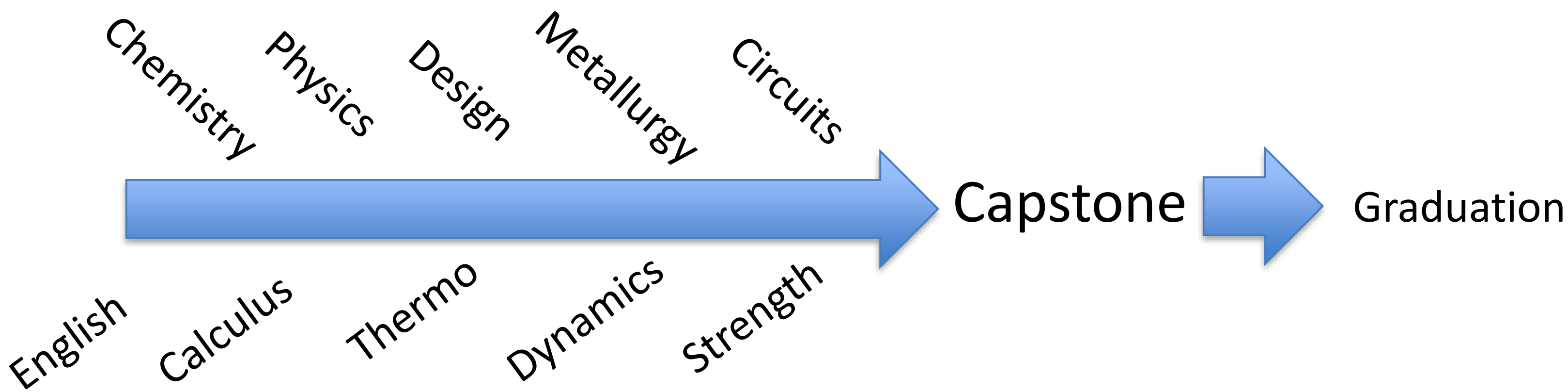
- Production Efficiency
- Reduced Natural Gas Consumption
- Reduced Wear and Tear

Cost Savings: ~$43,000 in first year

Recruitment Aspect

Partnering with Senior Design Students

- Senior design “capstone” project:
- One or two semesters,
- 1-4 students
- Part of a class (taken for credit).



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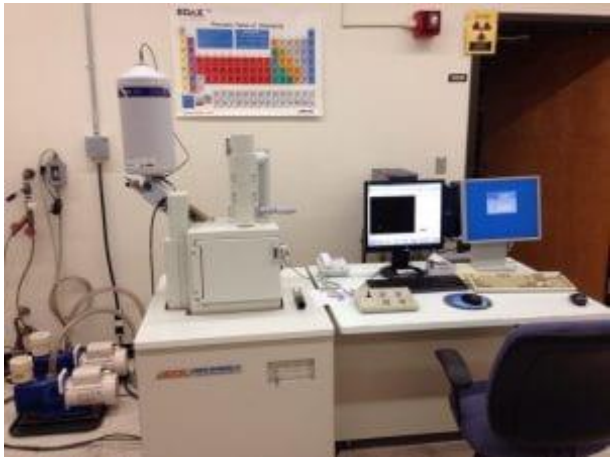
Pros and Cons

Benefits	Challenges
Technical input to drive project trajectories	Scoping projects
Early and deep look at potential recruits	IP (keep IP out!)
Leveraging University resources (instruments, faculty, staff)	Commitment of personnel time/effort

Instrument Capabilities



What do you need?

What is needed for a project:

- Project idea / scope
- Technical advisor from your company able to work with students (one hour per week, tour, end-of-semester presentations)
- Program fee (variable by school / program)
- Access to relevant company-specific resources (samples, advice, know-how)

Project Topics

Do's

- Focuses on student learning
- Utilizes concepts from multiple courses in their undergrad curriculum
- Exposure to an industrial application/process/product
- Value-Add to you, achievable in the course timeframe
- Open-ended, challenging
- Provides space for the students to take ownership

Do Not's

- A "To Do" list
- Related to an urgent production issue
- Sensitive to IP
- Uses equipment / instruments that are highly complex or difficult to access

Getting Involved

- Local university (or university of interest)
  - ✓ Department of interest
    - ✓ Department Chair (email or cold-call)

- Best time to contact is ~April. Projects are often gathered in late spring or summer

- Be up-front with faculty about why you are interested, what you want to get out of the partnership