Cast Steel Fatigue Project Proposal

Hayley Brown

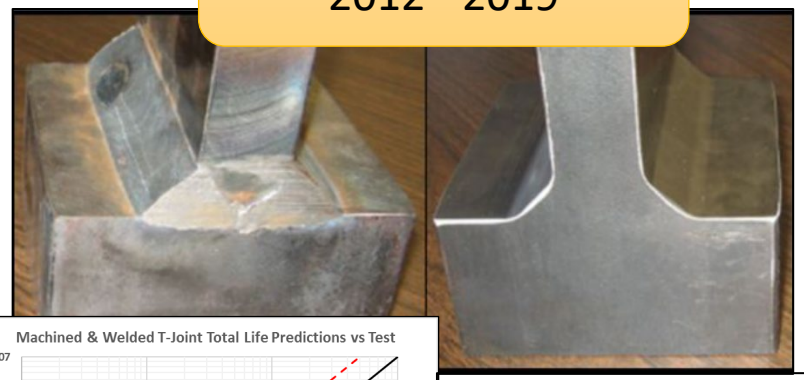
with

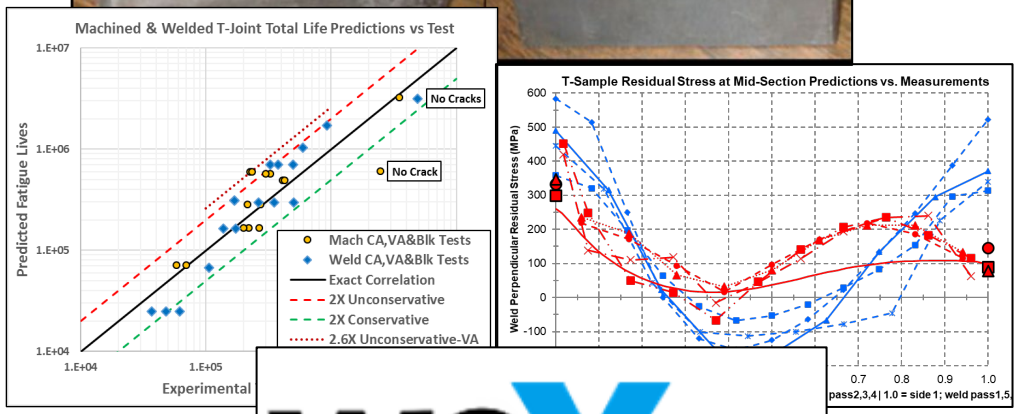
The Members of the Steel Casting Social Hour

FD&E Fall 2020 Meeting

FD&E Committee – 2012-2020

Total Life Project
2012 - 2019





WCX APRIL 9-11 2019 DETROIT

Presentation Downloads and Links:
https://www.fatigue.org/projects/total-life-project/total-life-at-sae-wcx/

RSC

Residual Stress Sub-Committee
2014 - Going Strong!

Gales Casey E <G… …yun Pan; + 29

SAE FD&E Residual Stress Committee 10/6/2020 Meeting Minutes

Start	End	Duration	Description	Presenter
…00 AM	8:00:00 AM	0:05	SAE FD&E Group Intro/Overview	Jim Patterson/Hayley Brown
…AM	8:30:00 AM	0:30	Fatigue Crack Growth Life Assessment using 3D Finite Element and Machine Learning Models	Adrian Loghin
…30:00 AM	9:00:00 AM	0:30	Comparison of Effective-Strain Based and Multi R-ratio Crack Propagation Models	Carol Liang
9:00:00 AM	9:30:00 AM	0:30	Residual Stress Subcommittee Update	Casey Gales
9:30:00 AM	10:00:00 AM	0:30	Predicted Distribution in Measured Fatigue Life From Expected Distribution in Cyclic Stress-STrain Properties Using a Strain-Energy Based Damage Model	Peter Huffman

Next Project

Call for new project ideas

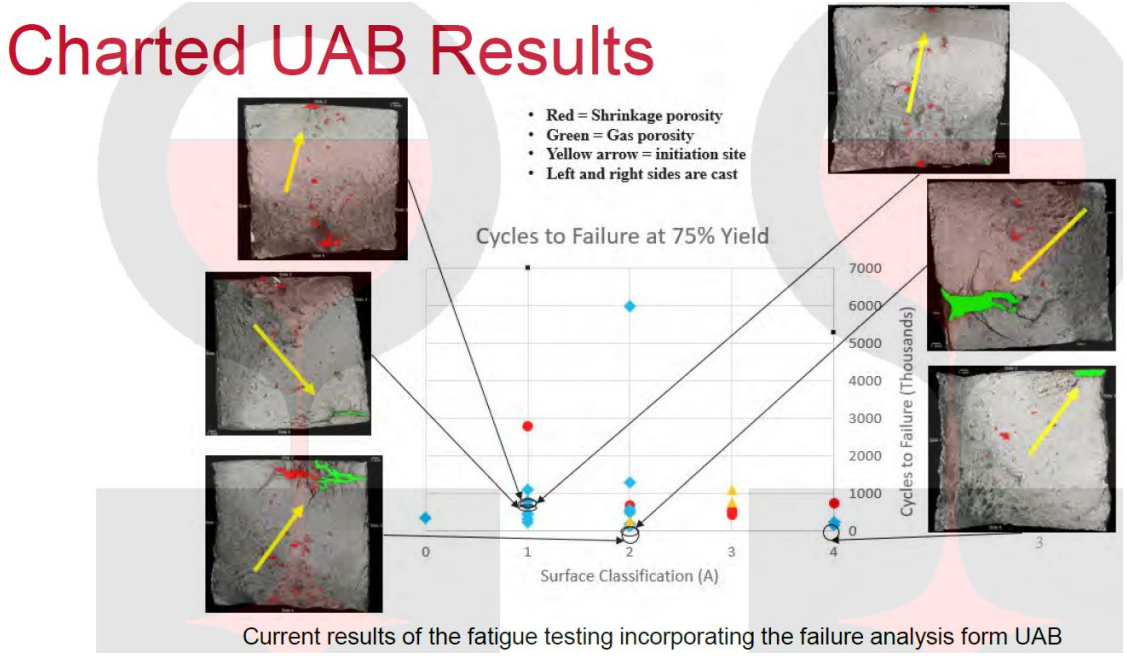
On Apr 25, 2019, at 4:57 PM, Gales Casey E <GalesCaseyE@johndeere.com> wrote:

FD&E Community,

- Project Discussion- What our next project should be/consider
  - Needs to be important to our companies
  - What is the scale of the next project? 1, 5, 10 years?
  - Needs a leader/driver
  - Needs to include and be relevant to all companies; Hendrickson, Emerson, CAT, Deere, MTS, Ford, HBM, Liebherr, ORNL, Academia, etc.
  - Cannot be proprietary information/processes
  - Should put together info/tools to use to solicit support (time and money) from our companies and contributors
  - Consider what has FD&E done in the past for projects

SFSA Reached out to FD&E…

And it turns out they had some research going on that our community was interested in, could be helped by, and could help with.



Current results of the fatigue testing incorporating the failure analysis form UAB

SFSA

Digital Innovative Design
for Reliable Casting Performance

Steel Performance Initiative

Indications and Fatigue Life, *Iowa State University – Frank Peters*
ISU is studying the theory that features such as inclusions and porosity limit the fatigue life of a cast steel component regardless of the surface roughness. To demonstrate this, ISU is running fatigue tests of as-cast and machined samples of both carbon steel (WCB in normalized condition) and low alloy steel (8630 in quenched and tempered condition) after thorough surface and radiographic inspection. The outcome of this work will provide the background for considering the actual (or statistically likely) crack-initiating feature during a fatigue analysis rather than using the historical approach surface finish-based curve adjustments.

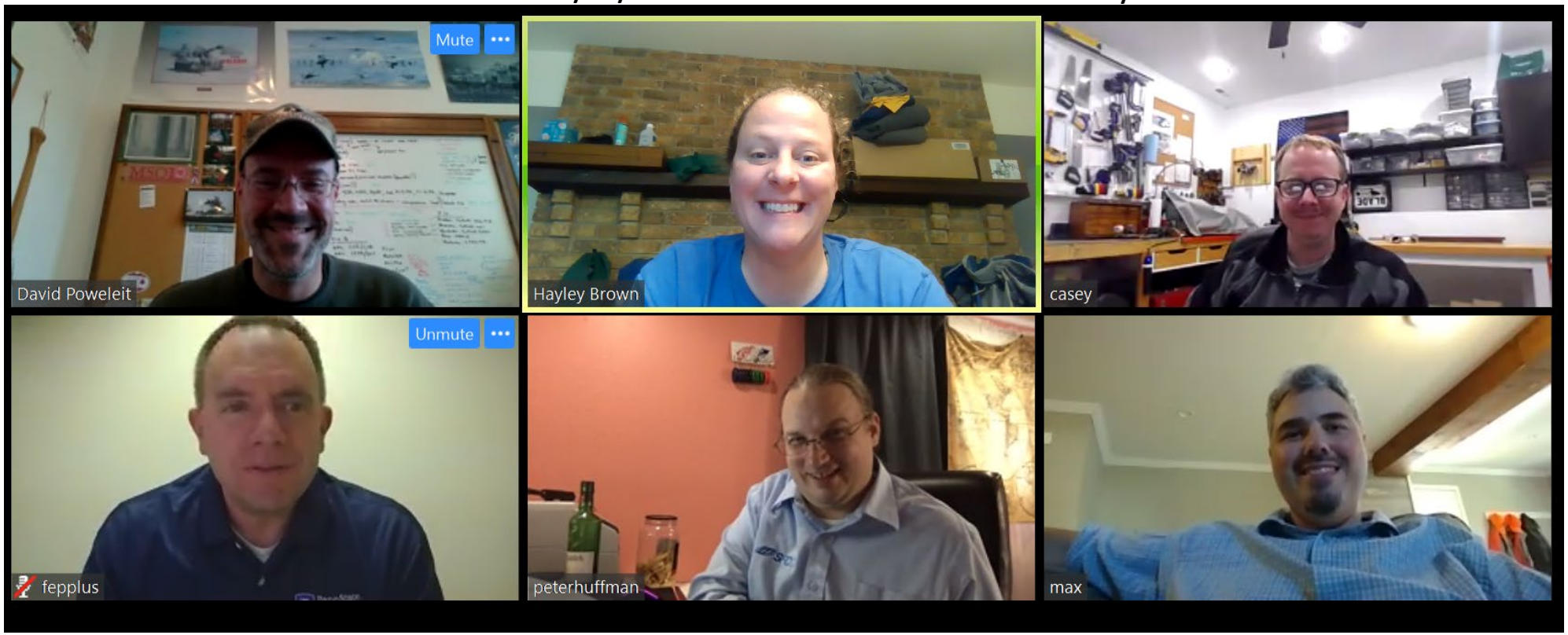
Solidification and Performance Modeling, *University of Iowa – Christoph Beckermann*
Casting solidification modeling will be integrated to performance analysis tools. This effort will enable the casting process solidification modeling results to predict local material and quality design properties to allow the component geometry to be digitally tailored to meet the performance requirements. Modeling and evaluation will be done on common cast steels and DoD alloys such as AF96 and FeMnAl.

Lower Bound Properties of Cast Steels, *University of Iowa – Christoph Beckermann and Richard Hardin*
SFSA has collected an extensive amount of mechanical property data for common cast steel grades. Using the same statistical approach used by MMPDS, A and B design allowables will be calculated to determine the design capability of common cast steels.

Project Topic + Busy Schedules + Pandemic + Beer

Steel Casting Social Hour

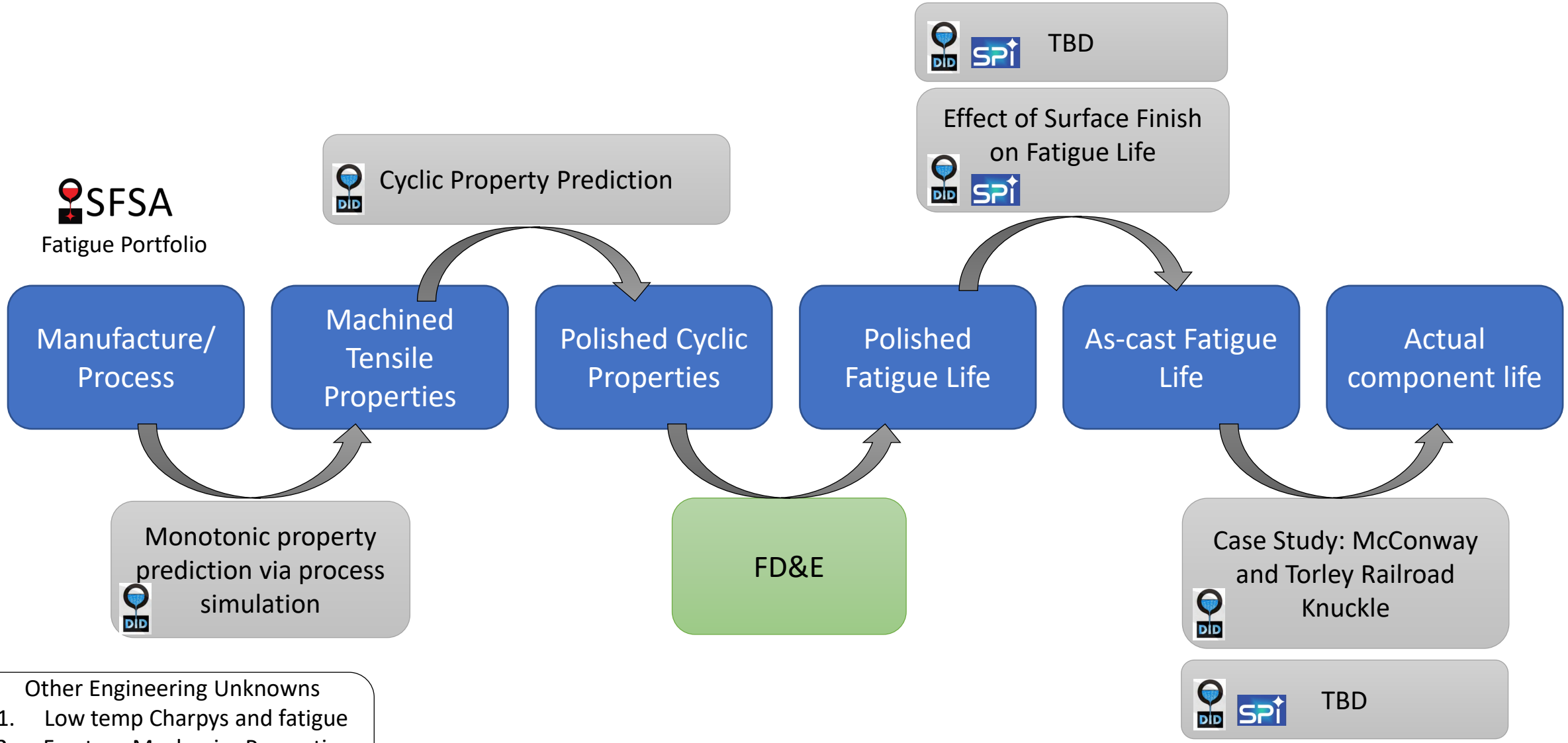
Dave Poweleit | Hayley Brown | Casey Gales



Frank Peters | Peter Huffman | Mike Maxeiner

Not pictured: Jim Patterson, Richard Hardin, Eric Norton

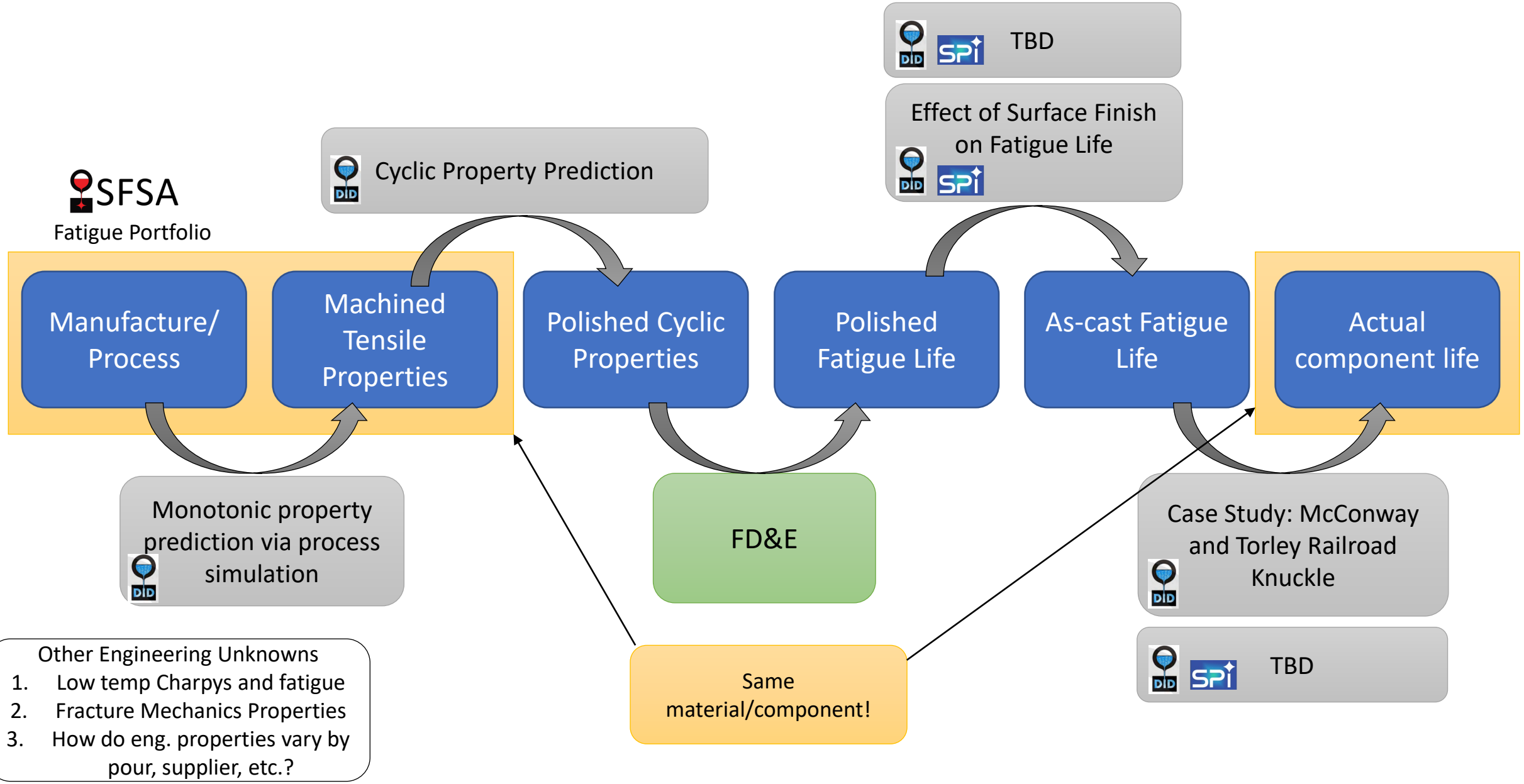
Current and Proposed Steel Casting Research



Other Engineering Unknowns

1. Low temp Charpys and fatigue
2. Fracture Mechanics Properties
3. How do eng. properties vary by pour, supplier, etc.?

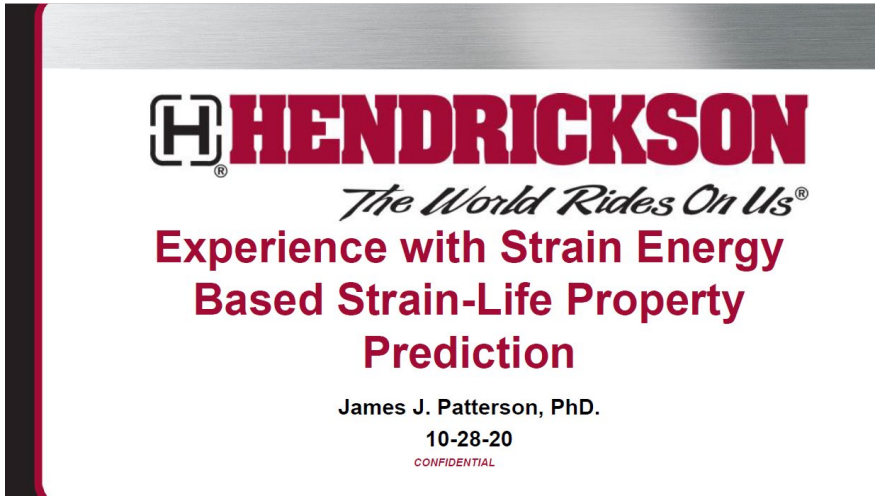
Unique (Awesome) Opportunity



What's in the FD&E Box?

Hopefully, FD&E will make the answer to these questions "YES!":

- Can we get a better fatigue estimation of one material very quickly?
- Can we get a better fatigue estimation of a lot of materials very inexpensively?
- We can't account for each little change in the steel casting process, but can we account for the sum of changes?



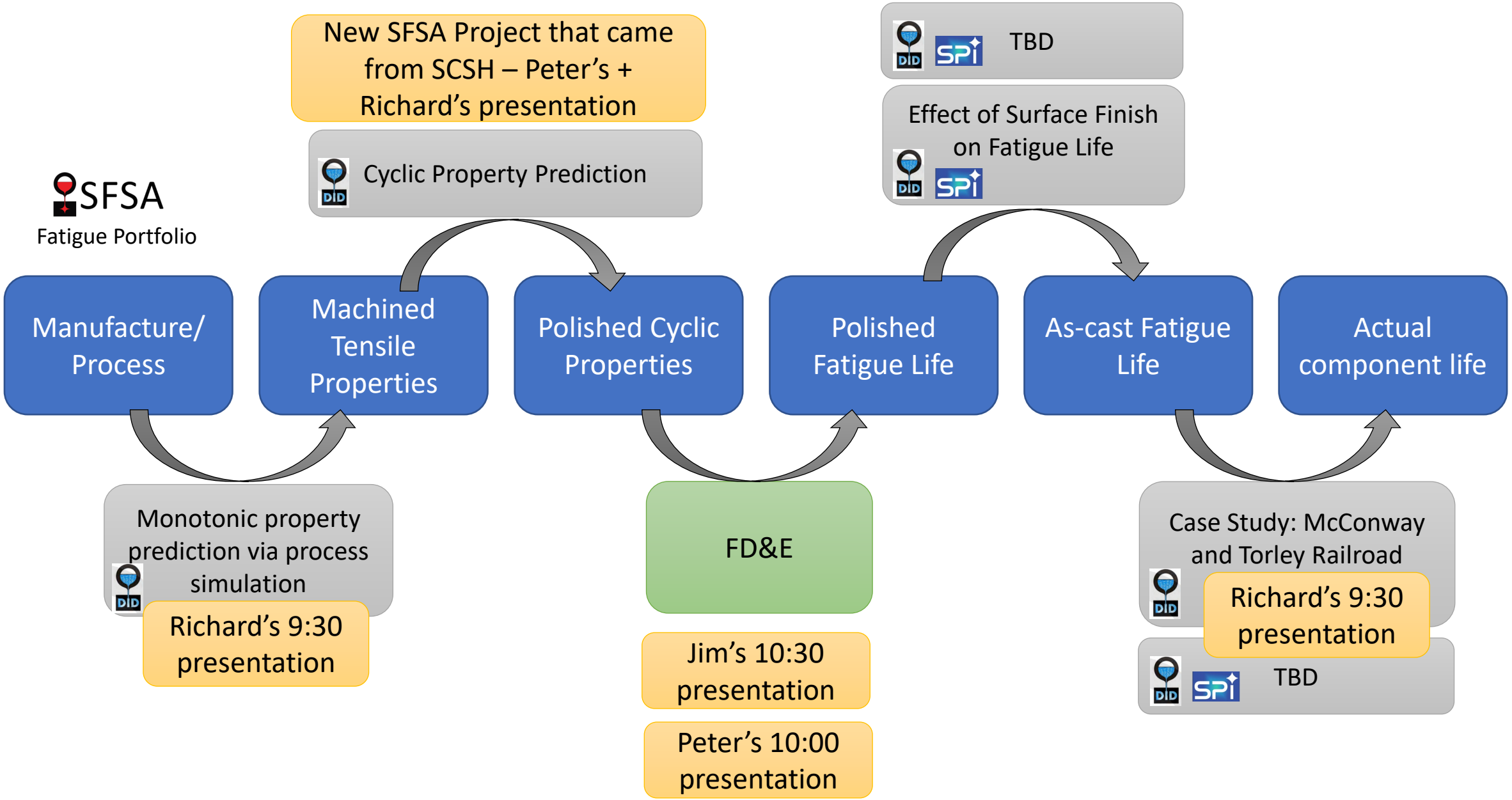
Project Goal and Research Path (Work in Progress)

Goal: Demonstrate that reasonable fatigue life estimations can be made with a reduced number (≤3) of fatigue tests for steel castings.

Topics/Tasks/Deliverables/Path/Gates/Items/Ideas:

1. Demonstrate that the strain-energy density approximation works for **?** number of cast steels with data from literature with **?** characteristics.
2. Demonstrate that the method works for the knuckle material (LCF polished fatigue tests of 8630 QT)
    1. Change carbon to see what happens
    2. Change the **?** to see what happens
3. Demonstrate that it works for another alloy that we have a component that we can fatigue test with – box beam? Real component?
4. Bring in total life project??
    1. As-cast T-joint vs. as-cast + machined T-joint vs. welded T-joint, vs. wrought + machined T-joint
    2. WCB vs. A36?

Bringing It All Together



What Do You Think?

- The members of the Steel Casting Social Hour believe that it's time to transition to a Real Project That Meets During Work Hours
- We would like feedback, buy-in, constructive criticism, etc. from the wider FD&E community
- We would LOVE to have others join in and participate

So far…

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SFSA

Who else?

To participate in the project or provide feedback, contact Hayley Brown at hbrown@sfsa.org

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