Flip-Chart Images for SUMMARY and CHALLENGES of the 2012 International Joints Workshop

Compiled by Dan Segalman
Dartington Workshop Report

SAND 2010-5458
Sandia Joints Handbook
SAND 2009-4164

Research Committee Site
http://committees.asme.org
/K&C/TCOB/BRTD/MJS/
WWW3.imperial.ac.uk/medynamics
/research/future/joints2009

Figure 1: Pad Number 1
1. Measurement of contact stiffness
   - how measured
   - understanding techniques

2. Variability in Joints
   - frictional shakedown
   - dependence on initial conditions

3. Mechanisms in friction
   - what causes energy loss
   - relevant length scales

Figure 2: Pad Number 2
1-4. Extend modeling scope
   - non-metals
     - e.g. rubber, gaskets,
   - thermo-mechanical contact problem

2-1. Interface mechanics modeling
   - bridging multiscale
     - temporal
     - spatial

2-2. Variability and uncertainty
   - stochastic modeling

2-3. Proceed in both directions of modeling
   - top down
   - bottom up
7-1 Get data!

Simple benchmark structure
Data are structure dependent
- load
- displacement
- time histories
- "slip"
- part-to-part
- assembly/disassembly

⇒ predictions of uncertainty

7-2 Reassess deterministic modeling
put uncertainty into such models
identify where uncertainty analysis is necessary
7-3 How do you discover model form error?

- Hierarchical constitutive models
- Thermodynamic consistency
5-1 "Intentionally" sliding interfaces
refinement of models
wear and friction dependency
on surface preparation

"Un-intentional" sliding
development of design criteria

5-2 Uncertainty management

5-3 Evolution and wear of interfaces
- spatial and temporal

Figure 6: Pad Number 6
3.1 Derive constitutive eqns. based on physical parameters
- Hardness
- aspenty (distribution)
- surface chemistry

Parameters are independently measurable

3.2 Compare models (simulations) on different hardware using different measurement techniques
- optoelectronic, etc.
- transient, steady-state
Are lap joints the best specimen to perform benchmarking studies?

- ball-on-flat
- dovetail
3-3 Compare non-local with local friction descriptions
   local e.g. Coulomb
   non-local e.g. bristle model

3-4 Compare the performance of passive, semi-active, and active joints
7-3 Can we use uncertainty principles to guide modeling techniques?

- Sensitivity analysis (no data required)
- Uncertainty (requires data)

Reducing order of model through such analysis

Michael Hanss
"Applied Fuzzy Arithmetic"
Toolkit for modeling
- experimental and analytical
- hierarchical

GRAND CHALLENGE

Develop prediction tools to design joints to perform "optimally".
4-1 Bottom-up approach to modelling structures

4-2
- better ways to parameterize models
- better ways to implement in FE models
- better joint models high dimension
- enlarge catalog of existing models

4-2 Need to engage analysts
research tool vs. production tool
4-3 How do we model joints in the absence of exp. data?

4-4 Engage broader community
- Industry
- Funding agencies
- Code developers (begin integration at earlier stage)
- Panel discussion at symposium comprised of code developers
Definition of a Grand Challenge

- discuss with stakeholders
- define deliverable date
  eg. deliver report at next IDETC on progress/actions

= Cost benefit of reducing the weight of a joint (?)
  - cost of joint failures
  - time to design
  - opportunity cost
Produce a statement of mission goals of research group

Website - Pablo

* Round Robin/Hysteresis Benchmark
  Dec 2012
  Apr 2013 - define scope, hardware measurement technique
  Mid-year progress
  Sept, 2013 - report results

* Same schedule for Joints Benchmark
- Methodology to quantify cost benefits
  Brake, Goyder, Ewins
  Reuss, Schmingshackl
  Allen

- Definition of calculation criteria

- How to pose question to stakeholders
  Dec. 2012 - draft delivery
Interface Mechanics

Define "Mechanisms of friction"

Grand Challenge -

Nowell
Brake
Eriten

"Green" paper
Jan/Feb 2013

1-4 Modelling non-metallics

Gaul, Goyder, Petrov
"Green" Feb. 2013

2-1 Multiscale Modeling Framework

Eriten, Pietr, Masud, Petrov
"Green" Feb. 2013

Figure 17: Pad Number 17
2.2 Variability and Uncertainty
link to round robins
Mignolet, Starr
Framework for data/criteria
Jan. 2013

7-2 Epistemic vs. Aleatoric modeling
Segalman, Bergman, Brake
Vakakis, Willner
Problem definition - Jan. 2013
5-3  Time-varying model parameters, modeling and experiment "Surface chemistry"

Dini, Medina, Eriten
Schwingshackl

- Problem definition, scales, wear
  Meeting at ISFF 7
  April 2013

3-1 \Rightarrow 16 \text{ merge with 2-1}

Gaul, Hoffmann, Mayes, Starr

Green paper Jan. 2013
3.2 VENN with 7-2, 3-3
8, 9
Non-lap benchmark = 9
3-3 crosslink to 14
7-3 ⇒ 11

18. Implementation in codes
Brown, Goyder, Petrov, Brake
Green paper - Jan. 2013
4-3 Crosslink to 13

Statement of Mission
Ewins, Bergman, Starr
Workshop Report