

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

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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

} GRAND CHALLENGE

Figure 2: Pad Number 2

1-4. Extend modeling scope

- non-metallics
eg. 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

Figure 3: Pad Number 3

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

Figure 4: Pad Number 4

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: Ppd Number 6

3-1 Derive constitutive eqns.
based on physical parameters

- Hardness
- asperity, (distributions)
- surface chemistry

parameters are independently
measurable

3-2 Compare models (simulations)

on ~~different~~^{some} hardware using
different measurement techniques

- optoelectronic, etc.
- transient, steady-state

Figure 7: Pad Number 7

Are lap joints the best
specimen to perform benchmarking
studies?

- ball-on-flat
- dovetail

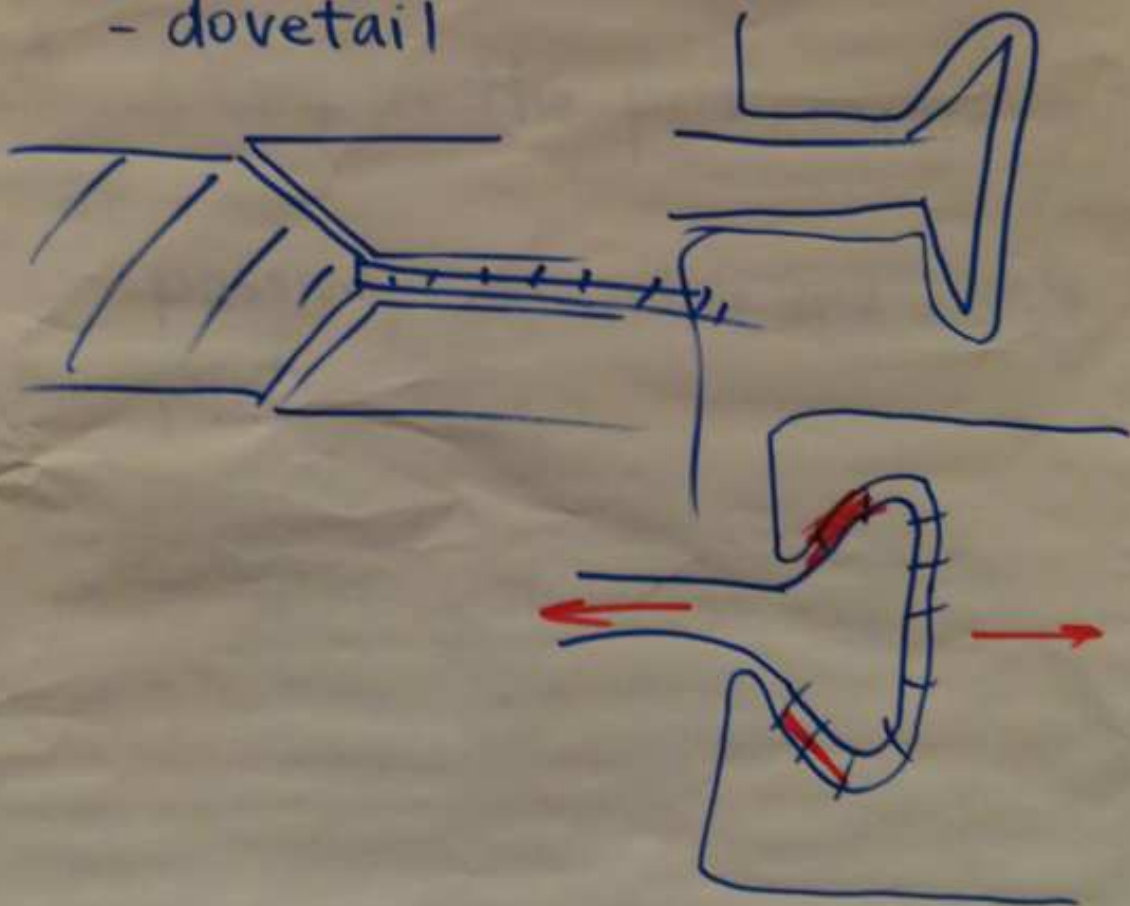


Figure 8: *Pad Number 8*

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

Figure 9: Pad Number 9

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 ~~Thompson~~
"Applied Hanss"
"Fuzzy Arithmetic"

Figure 10: Pad Number 10

Toolkit for modeling

- experimental and analytical

- hierarchical

GRAND CHALLENGE

Develop prediction tools to
design joints to perform
"optimally".

Figure 11: *Pad Number 11*

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
higher dimension
 - enlarge catalog of existing models

4-2 Need to engage analysts
research tool vs. production tool

Figure 12: Pad Number 12

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
-

Figure 13: Pad Number 13

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

Figure 14: *Pad Number 14*

Produce a statement of ^{mission} goals
of research group

Website - Pablo

* Round Robin/Hysteresis Benchmark

Dec 2012
2013

- April, define scope, hardware
measurement technique
- mid-year progress

- Sept, 2013 - report results

* Same schedule for Joints Benchmark

Figure 15: Pad Number 15

- Methodology to quantify cost benefits
Brake, Goyder, Ewins
Reuss, Schwingshackl
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, Petra Masud, Petrov
"Green" Feb. 2013

2-2 Variability and Uncertainty
link to round robins

Mignolet, Starr

Framework for data/criteria
Jan. 2013

7-2 Epistemic & Aleatoric modeling

Segalman, Bergman, Brake
Vakakis, Willner

Problem definition - Jan. 2013

Figure 18: Pad Number 18

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 ⇒ IG merge with 2-1

Gaul, Hoffmann, Mayes, Starr
Green paper Jan. 2013

Figure 19: Pad Number 19

3-2 VENN with 7-2, 3-3
8,9

Non-lap benchmark \Rightarrow 9

3-3 crosslink to 14

7-3 \Rightarrow 11

18. Implementation in codes

Brown, Goyder, Petrov, Brake

Green paper - Jan. 2013

Figure 20: *Pad Number 20*

4-3 Crosslink to 13

Statement of Mission

Ewins, Bergman, Starr

Workshop Report

Figure 21: *Pad Number 21*