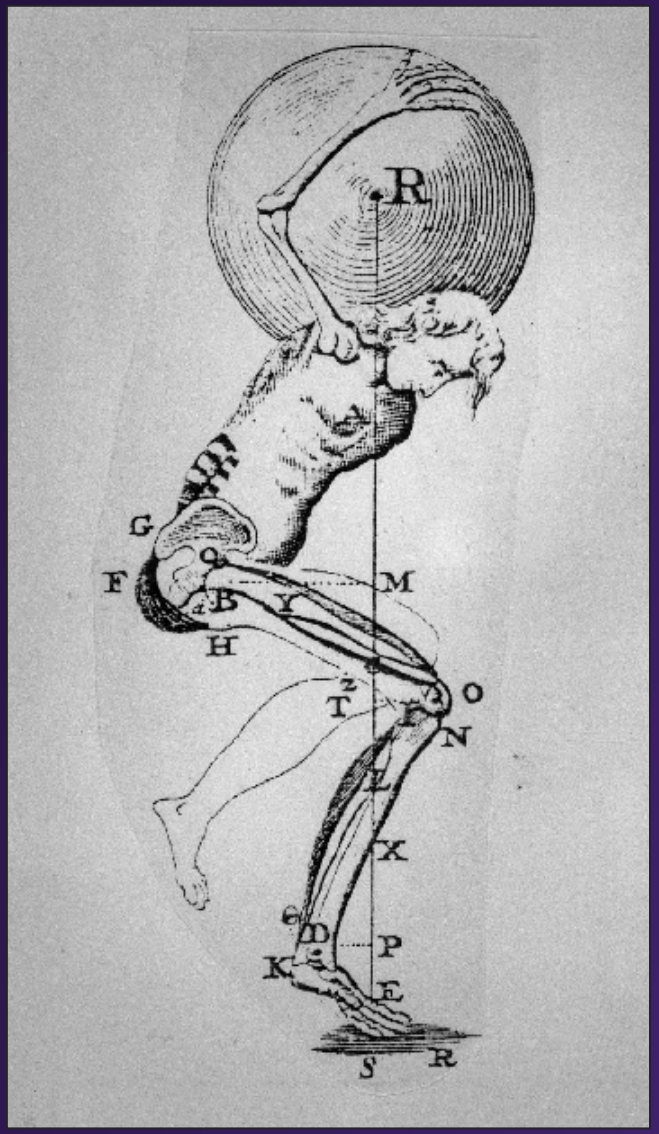


Musculoskeletal Biomechanics

BIOEN 520 | ME 527

Session 2B

Experimental Study Design

Review: Session 2A…

- Reviewed basic concepts in engineering mechanics
- Examined viscoelasticity and how it relates to biomechanics

Session 2B...

[Q]: What is the "Scientific Method"?

[Q]: What study designs are typically used in biomechanical research?

[Q]: What two key input/output variables are used in biomechanics?

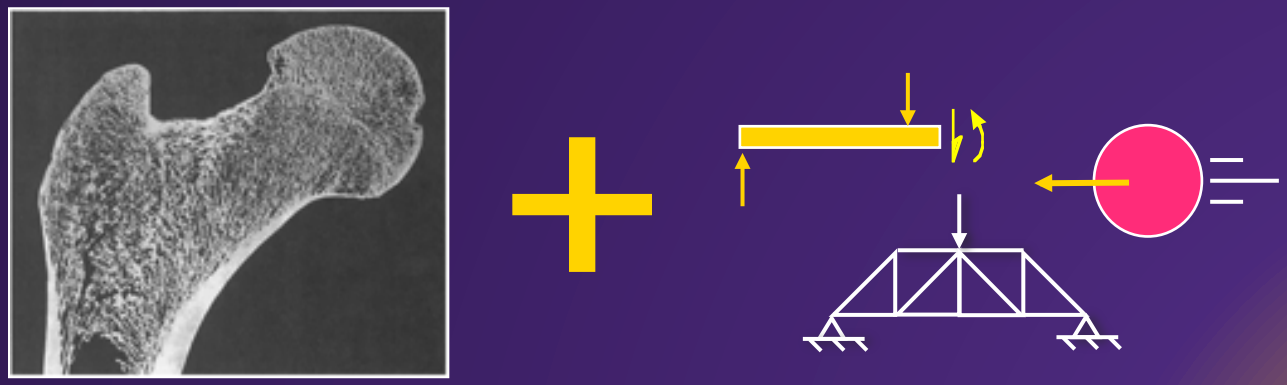
[Q]: From these variables, what metrics can be derived and used in characterizing / comparing biomechanical properties?

[Q]: What experimental models are commonly used in biomechanics research?

Session #3...

[Q]: How do we begin to "apply" mechanics to the musculoskeletal system?

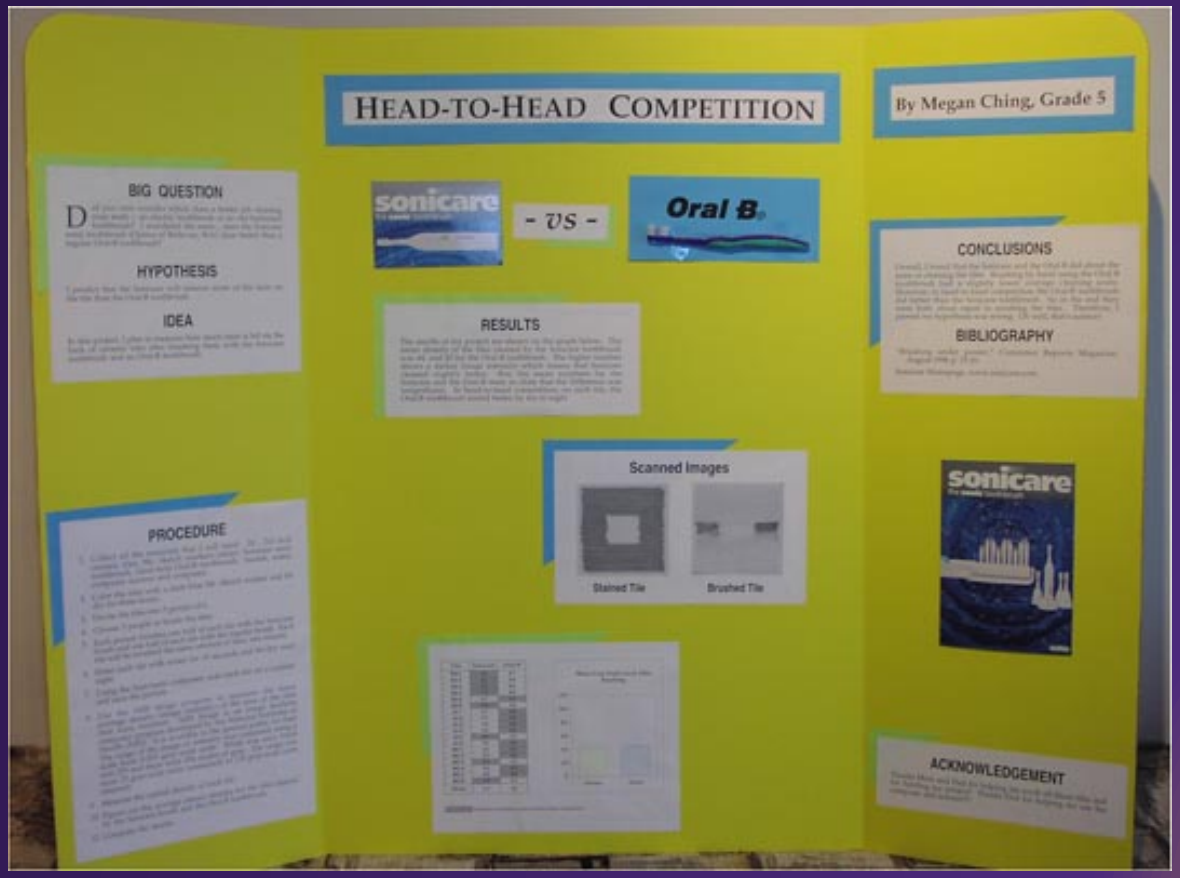
- *We know the anatomy we want to study...*
- *We know basic engineering mechanics...*



What should we consider when designing a study?

The “Scientific Method”…

[Q]: Did you ever do a “Science Fair” project?



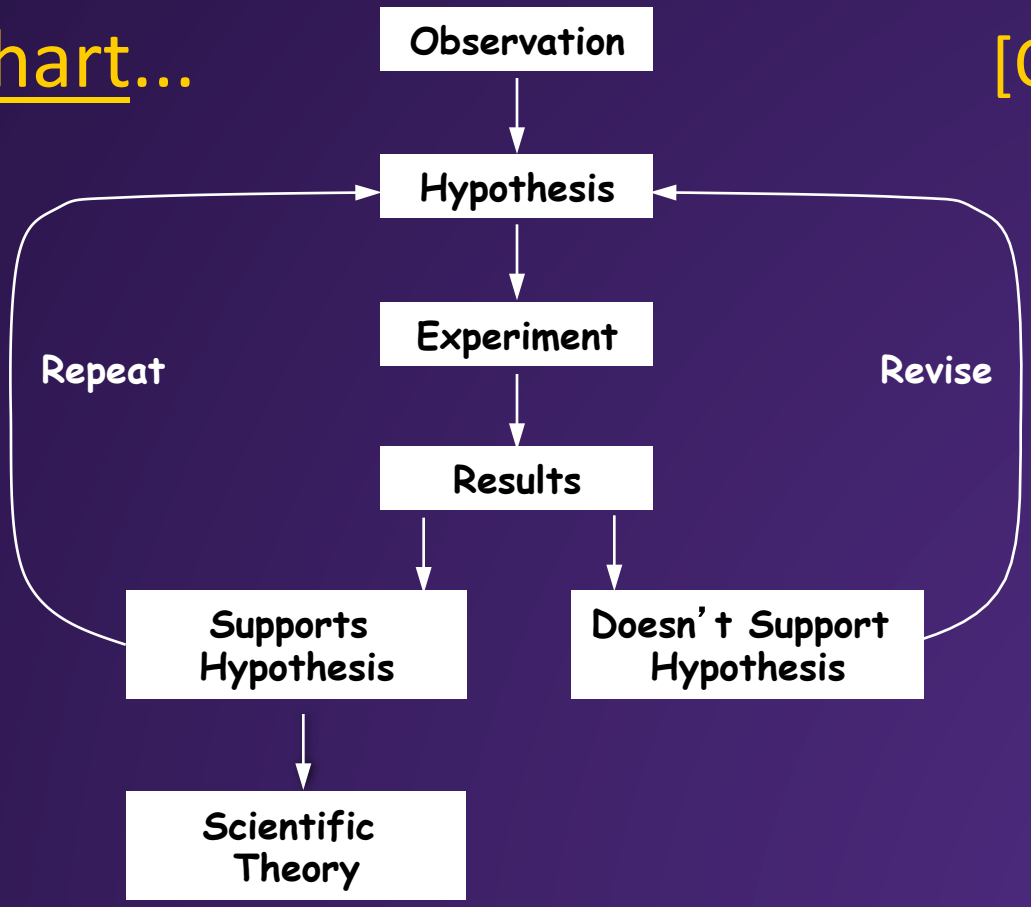
The "Scientific Method"...

[Q]: What is the "Scientific Method?"

- *Identify a question...* *[Observation]*
- *Develop a hypothesis...* *[Hypothesis]*
- *Test the hypothesis...* *[Experimentation]*
- *Interpret the results...* *[Interpretation]*

The "Scientific Method"...

Flowchart...

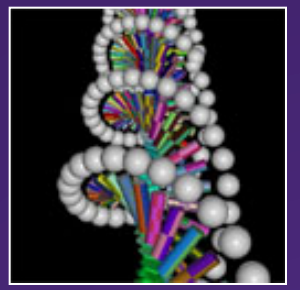


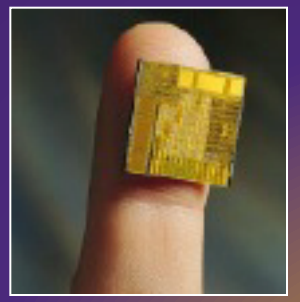
[Q]: Does all research follow this process?

Basic vs. Applied Research…

[Q]: What is the difference between "basic" and "applied" research?

- *Basic: Hypothesis driven*
  (...follows the scientific method to test a hypothesis)
- *Applied: Problem solving*
  (...collects data to answer a specific question or optimize a solution)





Study Design...

[Q]: What types of study designs are commonly used in biomechanics research?

- *Controlled Laboratory Study*
  (compares treatments - e.g., implant A vs. B)
- *Descriptive Laboratory Study*
  (describes characteristics or property - e.g., anthropometry)
- *Review Study*
  (no experiments - reviews existing literature)

Study Design...

[Q]: What other factors should be considered when designing a study?

- *Control Group* { *Between-Groups Comparison*; *Repeated Measures (within a group)* }
- *Randomization*
- *Prospective vs. Retrospective*
- *Replication (a.k.a., Repeatability)*

Input and Output Variables...

[Q]: What are "input" and "output" variables...

...*in mathematics?*	y = sin(x)
...*in programming?*	trunc(raw, digits, return)
...*in research?*	Independent / Dependent

Input and Output Variables…

[Q]: Based on our definition of mechanics, what are the 2 most fundamental input and/or output variables for a biomechanical study?

- *Load (force or moment)*
- *Displacement (motion or deformation)*
- *Control Variables (rate, temp, age, gender, etc…)*

Metrics/Parameters…

[Q]: From *load* and *displacement*, what metrics can be used to characterize or compare biomechanical response?

- *Stress-Strain*
- *Stiffness / modulus*
- *Failure Load / Strength*
- *ROM / Ultimate Strain*
- *Hysteresis / Creep / Stress Relax.*
- *Many others (…fatigue strength, toughness, etc.)*

Experimental Models...

[Q]: What are typical experimental models used in biomechanics research?

- *Human Subjects (live volunteers)…*
- *Human Tissues (cadaver)...*
- *Animal Subjects/Tissues...*
- *Dummies/Manikins...*
- *Others Physical Models...*

Test Enviroment...

[Q]: What environmental factors are important in biomechanics experiments and why?

- *Temperature*
- *Humidity*
- *Time (from tissue harvesting and no. of freeze-thaw cycles)*

Other Control Variables…

[Q]: Besides environmental factors, what other variables should be considered/controlled?

- *Age*
- *Gender*
- *Size (ht./wt.)*

Sample Size...

[Q]: How can we determine how many test specimens to test?

Statistical Power Analysis -- to reduce chance of Type I (false "+") and II (false "-") errors

On-line Calculators & Programs:

http://statpages.org/#Power

http://www.quantitativeskills.com/sisa/calculations/samsize.htm

http://www.gpower.hhu.de/en.html

} *Need pilot data!*

Study Design Summary…

Air Cylinder Example…

Bimba Original Line – Stainless Steel Body Air Cylinders

How to Order

The model number of all Original Line cylinders consists of three alphanumeric clusters. These designate product type, bore size and stroke length, and mounting styles and options.

Please refer to the charts below for an example of model number BR-013-DBEE0.5. This is a rear block, 7/16" bore, 3" stroke double acting cylinder with bumpers and an extra extension of 1/2".

TYPE

BXX – Block or Trunnion Mounted (BF, BR, BFT, BRT, BFM, BRM, BFTM, BRTM)
C – Cushion
(CR, CF, CS, CM, CRM, CFM, CSM)
H – Hydraulic cylinder
M – Magnet option for standard cylinders
MRS® – Magnetic Reed Switch Cylinder
SR – Stainless rod, if nonstandard

BORE SIZE/POWER FACTOR

007 – 5/16"	12 – 1-1/4"
01 – 7/16"	17 – 1-1/2"
02 – 9/16"	24 – 1-3/4"
04 – 3/4"	31 – 2"
06 – 7/8"	50 – 2 1/2"
09 – 1-1/16"	70 – 3"

STROKE LENGTH

In inches and decimal fractions, i.e. 1.75 (See individual models for standard and maximum stroke)

BR-013-DBEE0.5

MOUNTING STYLE

(see individual bore sizes for designations)

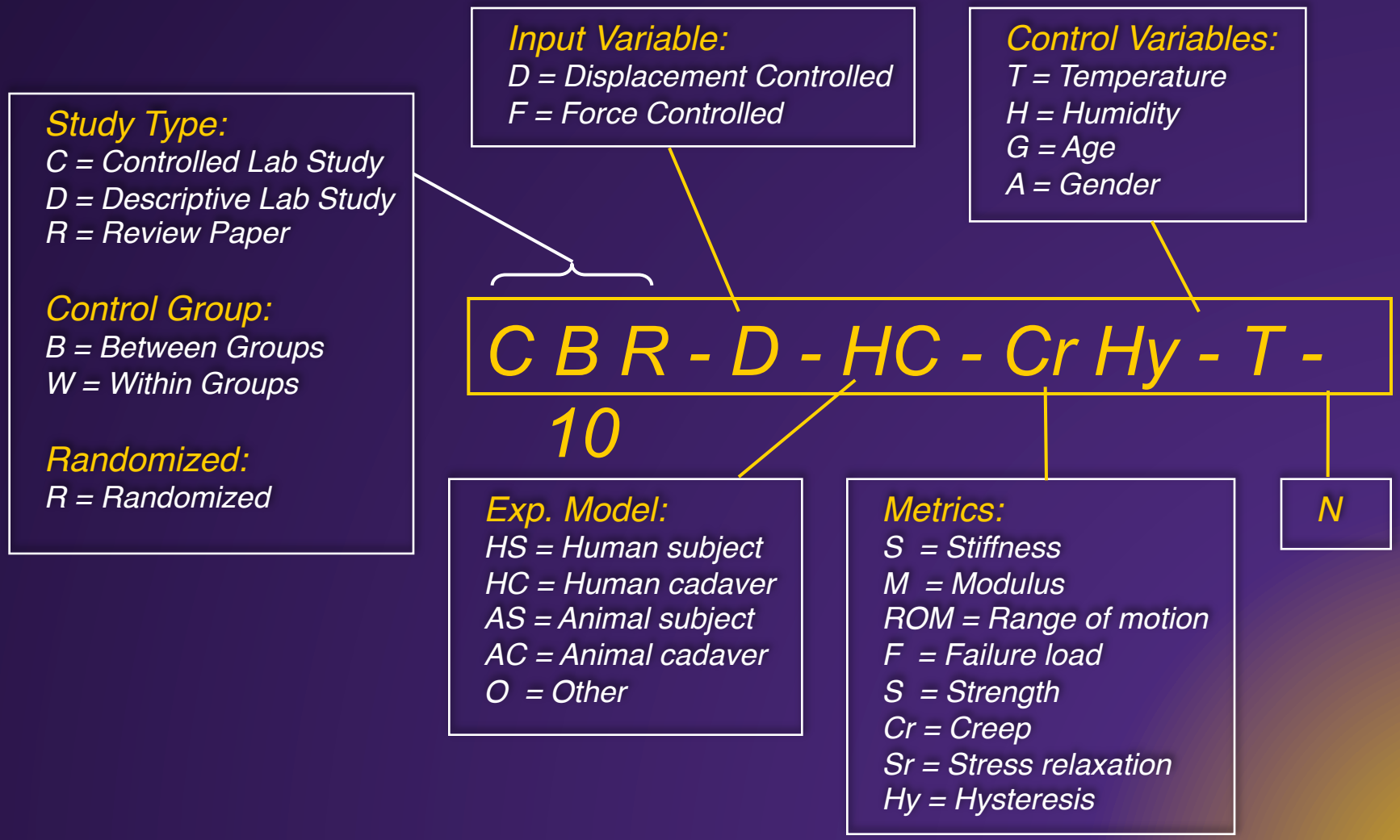
OPTIONS*

(in alphabetical order, except for EE which is last)

B	–	Bumpers
E	–	Seals and factory lubrication for long life in non-lube applications
EEX.XX	–	Extra Rod Extension of X.XX
F	–	Molycoated body
G	–	Magnalube® G Lubrication
H	–	Heavy Spring (H designated before mounting style)
K	–	Ports rotated 90°
N	–	Low temperature seals & lubrication
NT	–	No Thread
Q	–	Side ported rear head
V	–	High temperature seals & lubrication
W	–	Wiper
Y	–	Pivot bushing replaces pivot pin

** Consult your distributor or option combination availability chart page 4.*
®Magnalube is a trademark of Carleton Stuart Corporation.

Study Design Summary…



In-Class Group Discussion...

[Q]: In the papers by Lee et al. and Whittaker et al., compare and contrast the study designs (including models and statistical analyses used in hypothesis testing)?