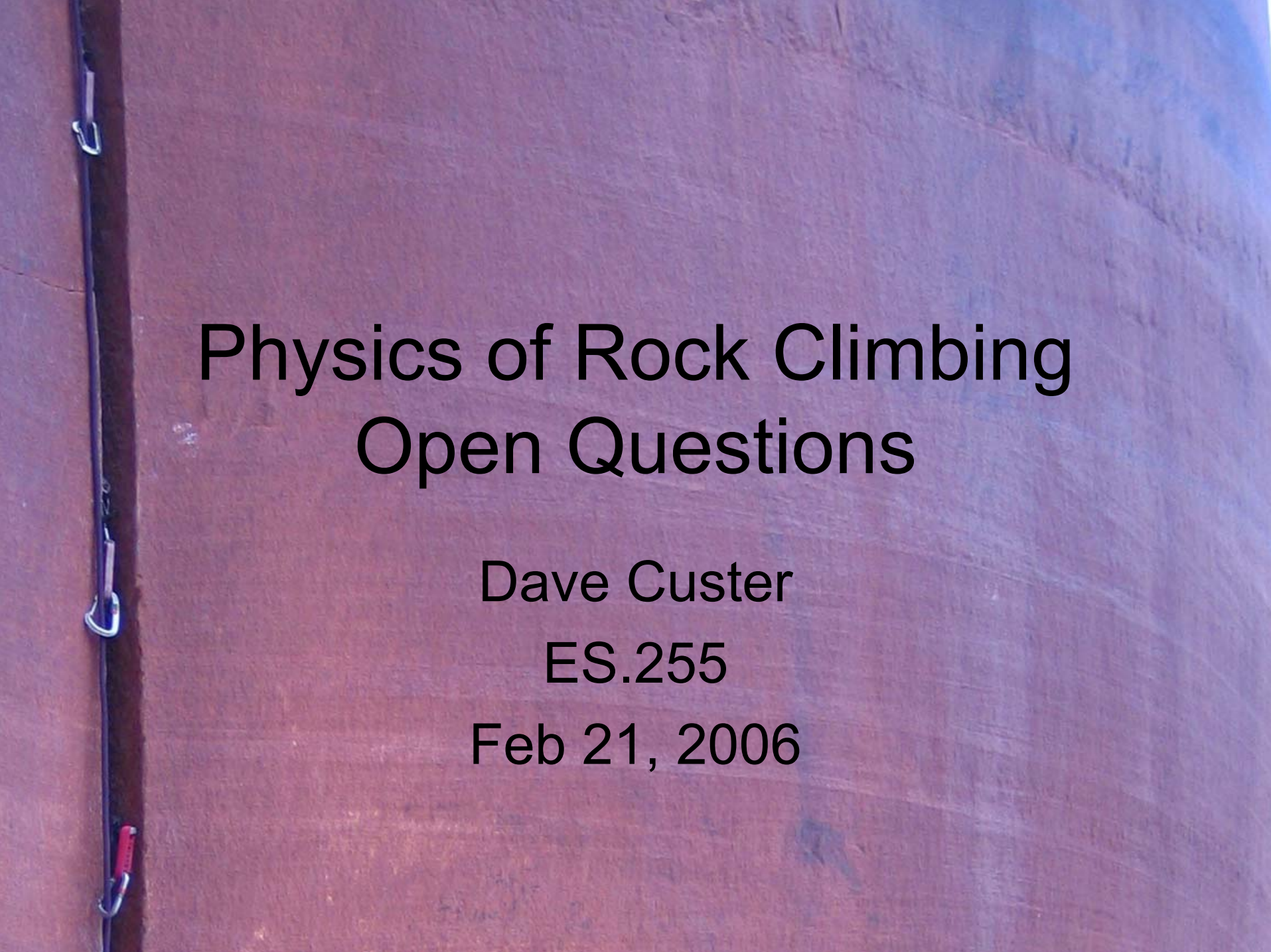


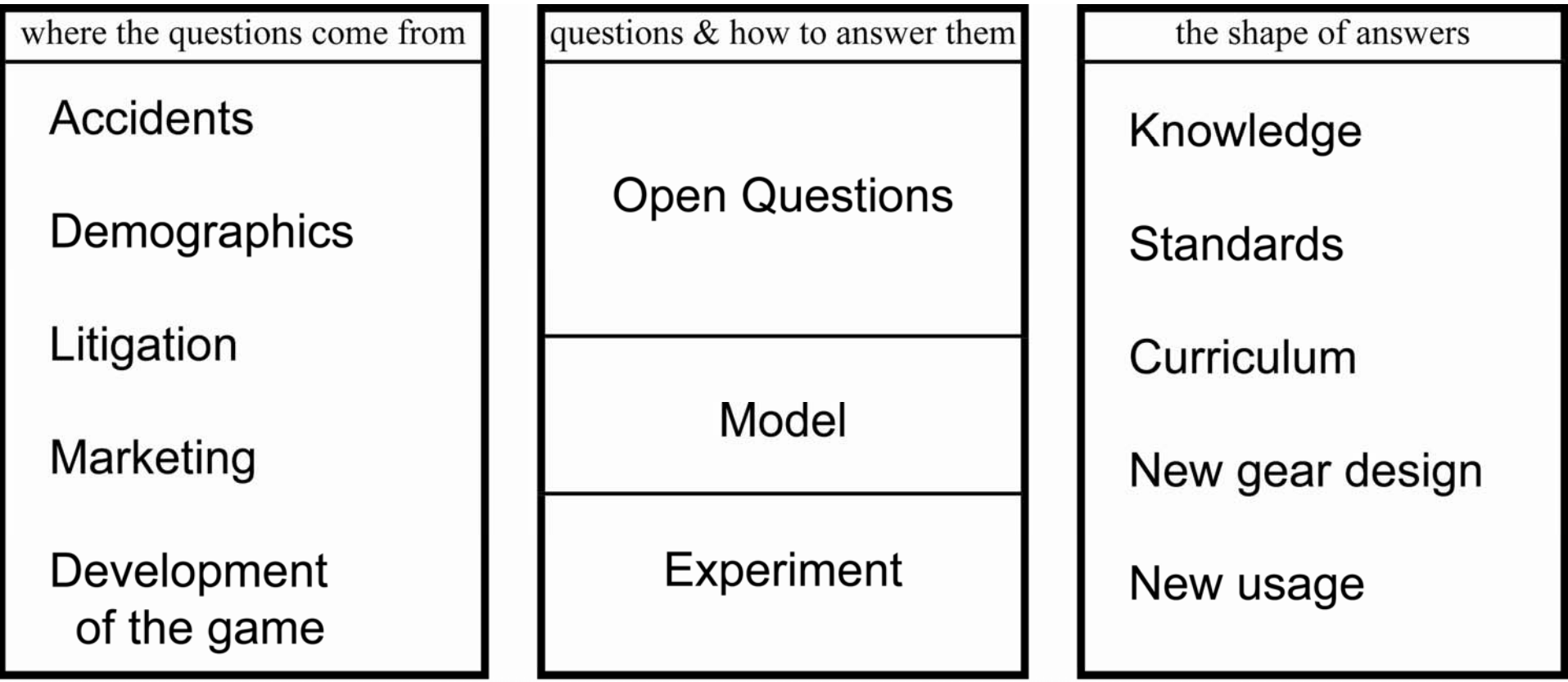
Physics of Rock Climbing
Open Questions

Dave Custer

ES.255

Feb 21, 2006

Overview


where the questions come from
Accidents
Demographics
Litigation
Marketing
Development of the game
questions & how to answer them
Open Questions
Model
Experiment
the shape of answers
Knowledge
Standards
Curriculum
New gear design
New usage
information access/bibliography

Safety

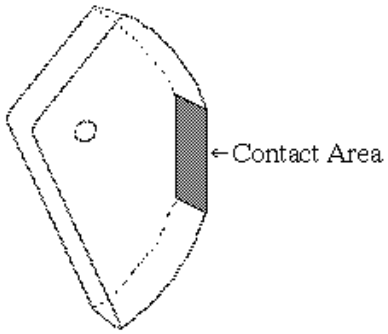
- Component approach
- System approach
- Social/Organization approach
- Personal approach
- SP.255 approach

Question Beggars

- Accidents:
- Innovation: The equipment gets “better”
- Demographics: Age, latitude…
- Behavior: How people climb
- Related sports & occupations:
- Marketing:
- Litigation:
- Standards & Standardization:

The Answer Mill

- Modeling
- Experiment
- Simmering



Modeling

$$A_{contact} = 2\sqrt{\frac{4F_{normal}(1-P^2)R_{adius}W_{idth}}{\pi E}} \quad (4)$$

		<==Inputs	Calculated==>			working on lamda	
m climber	m belayer	F bd	h simple	l simple	ff simple	lambda	h
80.0	80.0	2.0	5.7	9.9000	0.69	0.4791	6.1
80.0	80.0	2.0	5.7	0.9000	1.62	0.1507	5.8

$$\sigma_{xt} = \frac{T}{A} = \frac{F\sin\theta}{2\pi R_2^2}$$

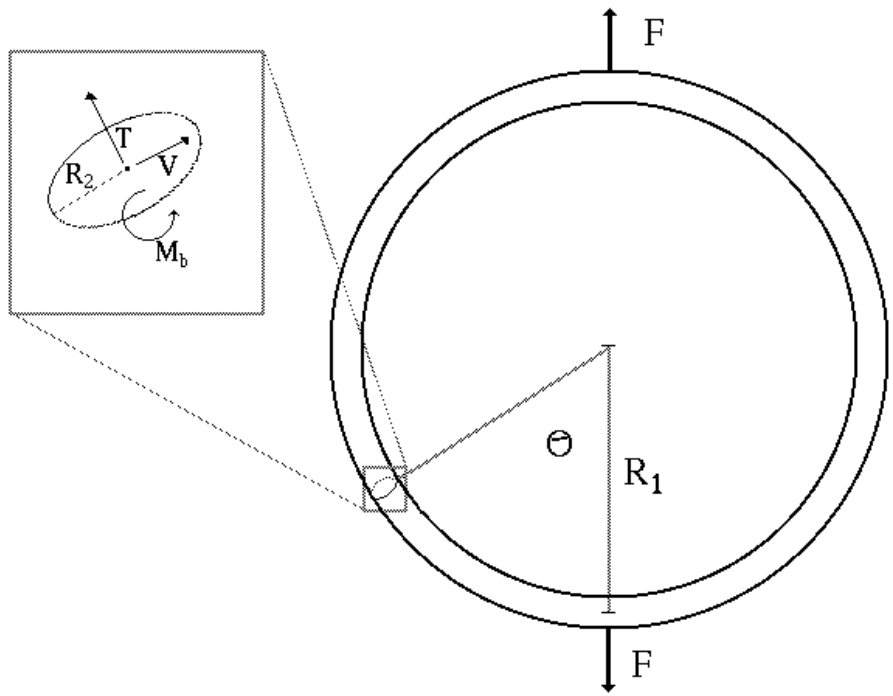
$$\tau_{yz} = \frac{V}{A} = \frac{F\cos\theta}{2\pi R_2^2}$$

$$\sigma_{xm_b} = \frac{M_b r}{I_\emptyset} = \frac{\frac{1}{2}FR_1r_2(\frac{2}{\pi}-\sin\theta)}{\frac{\pi}{4}R_2^4}$$

$$T = \frac{1}{2}F\sin\theta$$

$$V = \frac{1}{2}F\cos\theta$$

$$M_b = \frac{1}{2}FR_1(\frac{2}{\pi}-\sin\theta)$$



Classification of Qs

- System components
- Systems & interactions
- Use & habits

System Components

- Ice axes—multiple uses perhaps deserve multiple standards
- EAS—standards & education
- Ropes—waterproofing, middle marker, sharp edge resistance, & abrasion resistance
- Aid Hooks—strength standard
- Belay/rappel devices—standards, usage, & performance measures
- Cams—new axel configuration analysis
- Ice screws—build a better ice screw & testing/standardization
- Bolts—warm, wet, & salty + sustainability
- Pads—use & standards
- Crampons—snow ball effect
- *Nuts*
- *Slings & draws*
- *Harnesses*

Systems and Interactions

- Crampon + boot
- Rappel/belay device + rope (+user)
- Carabiner + rope (frequency, radius of curvature, standards, education)
- Rappel/belay device + heat
- Via ferrata
- Artificial climbing walls

System Example: Via Ferrata

VF Outcomes

Use and Habits

- Official line vs. actual use (e.g. grigri)
- Belay methods
- Bouldering pads
- Lead climbing decision making

Use & Habits Examples

- DAV work on
  - Gym belaying
  - Avalanche awareness
  - Falling over

The Shape of Answers

- Curriculum
- Standards
- Better equipment
- Better habits and equipment use
- Information

ES.255 Physics of Rock Climbing
Spring 2006