Carleton University Crash Dummy

Crash-test dummy

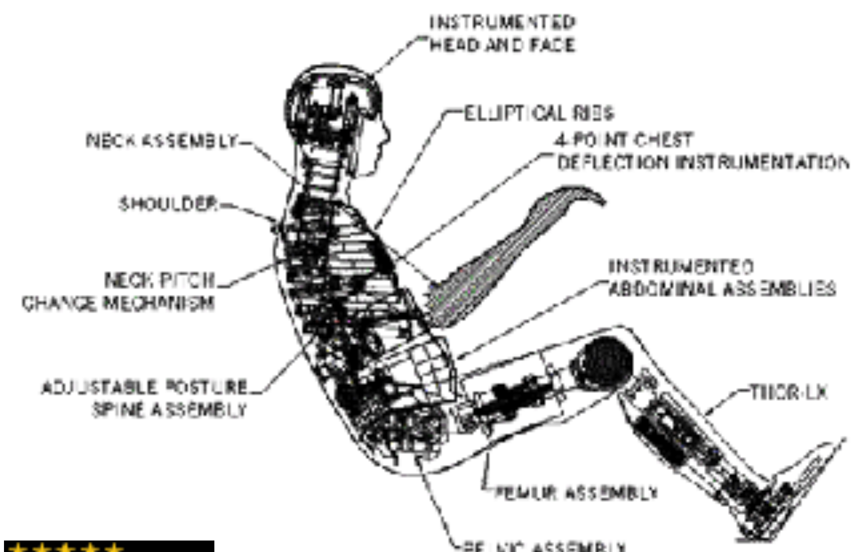
Used to test (and improve) automobile safety

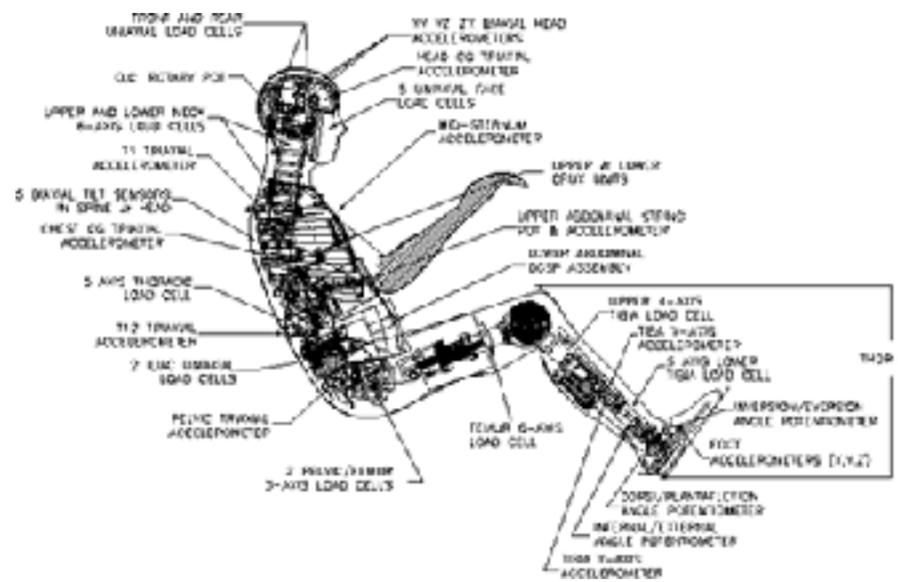
Crash-test dummy

Also used in helicopter/aircraft testing

Crash-test dummy

Government regulated
- Specifications and drawings available
- Little room for innovation
- Different crash configurations need different dummies

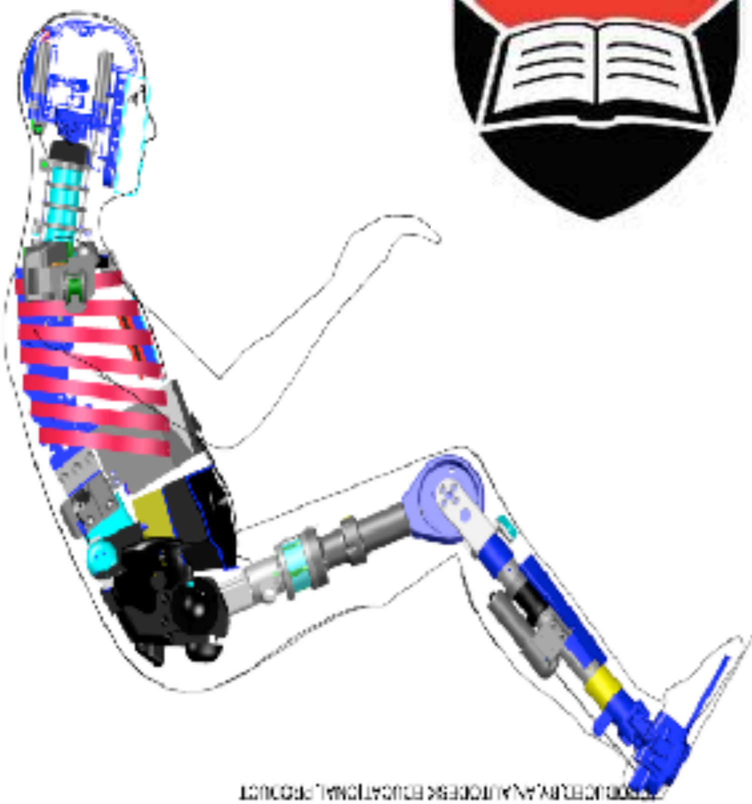




THOR Advanced Crash Test Dummy,

Crash-test dummy

THOR-NT



CUCD

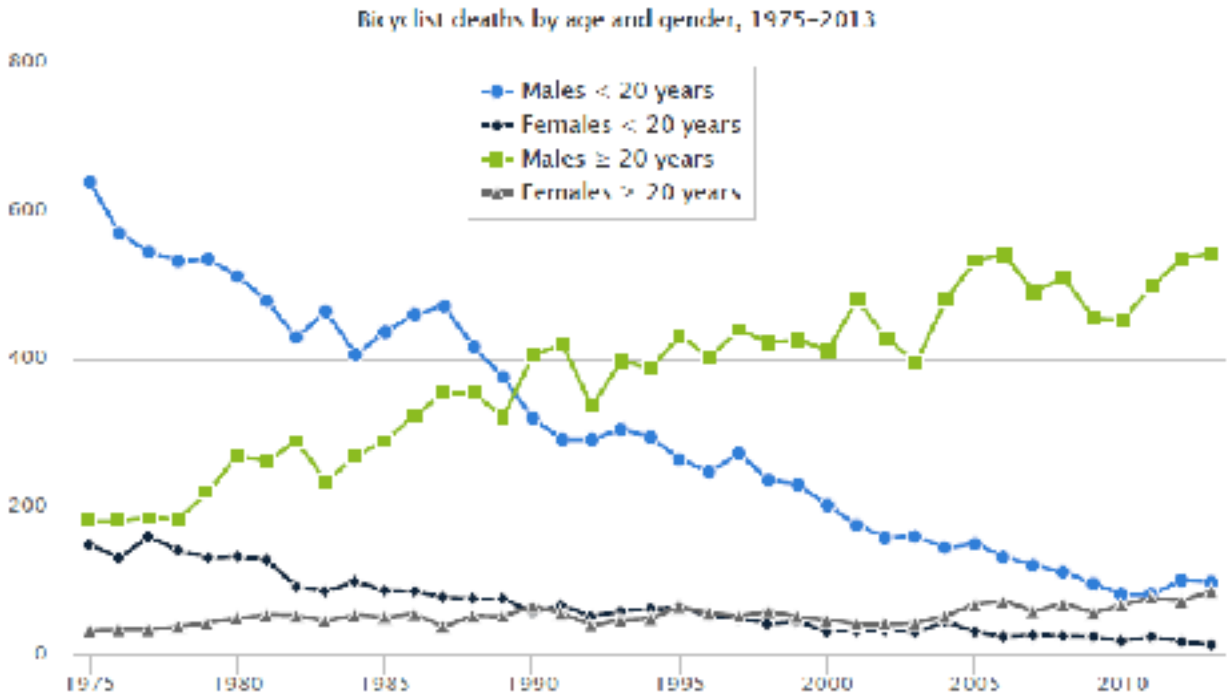
CARLETON UNIVERSITY CRASH DUMMY

POLICE

Ottawa


07/15/2017 12:07:59

Crash-test dummy



Insurance Institute for Highway Safety

Crash-test dummy

Table 1. Trends in Number and Type of Bicycle Injury and in Hospital Admissions From 1998 to 2013

	1998-1999	2000-2001	2002-2003	2004-2005	2006-2007	2008-2009	2010-2011	2012-2013	% Change[c]	P Value[b]
No. of injury cases[c]	8791	9775	9633	10 068	11 133	13 046	14 322	15 427		
Age adjusted incidence[d]	96 (84-108)	99 (87-110)	90 (79-101)	89 (78-99)	96 (85-108)	107 (95-119)	114 (102-126)	123 (110-136)	28	.02
No. of hospital admissions[c]	553	629	707	833	966	1239	1377	1646		
Age-adjusted incidence[d]	5.1 (2.4-7.8)	4.8 (2.4-7.3)	4.9 (2.6-7.3)	5.7 (3.2-8.1)	6.1 (3.5-8.7)	7.8 (4.9-10.8)	9.1 (6.0-12.2)	11.2 (7.6-14.9)	120	.001
Type of injury, % (95% CI)										
Head	10 (6-14)	10 (5-14)	10 (6-15)	12 (7-16)	12 (7-16)	14 (9-19)	15 (10-19)	16 (9-21)	60	<.001
Torso	14 (10-18)	14 (10-18)	14 (10-18)	15 (11-19)	16 (11-20)	16 (12-20)	17 (12-22)	17 (12-22)	20	<.001
Extremity	59 (46-72)	60 (45-74)	59 (43-71)	57 (41-70)	56 (41-70)	55 (41-70)	53 (40-67)	52 (37-66)	−12	<.001
Other body part	17 (11-23)	17 (12-22)	17 (11-22)	16 (11-22)	15 (11-22)	15 (11-21)	15 (10-20)	16 (10-20)	−9	.004
Location (street), % (95% CI)	40 [illegible]	43 [illegible]	49 [illegible]	55 [illegible]	53 [illegible]	52 [illegible]	54 [illegible]	56 [illegible]	40	.005
Large hospital, % (95% CI)[e]	53 (35-71)	51 (29-73)	50 (31-69)	51 (31-72)	49 (27-70)	50 (31-69)	53 (34-73)	57 (32-82)	8	.31

Sanford et al., Journal of the American Medical Association, 2015

Crash-test dummy

Bike Crashes: Cyclist hit by car
- from rear
- from side

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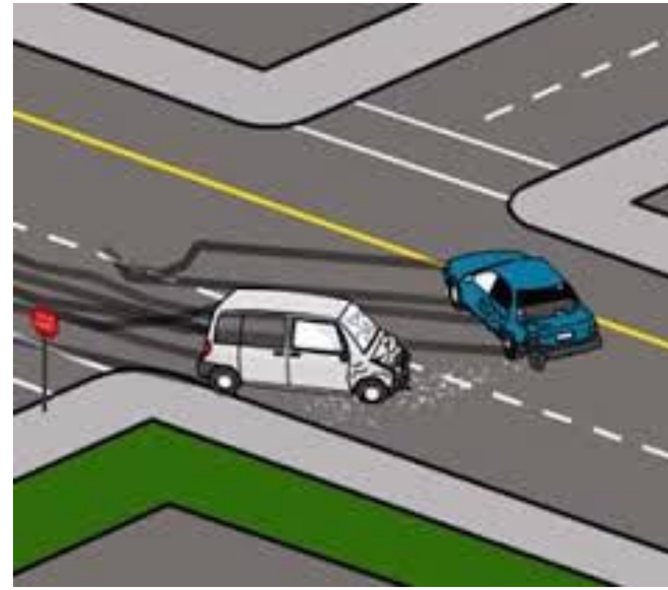


KNOW TWO WAYS OUT!
?

Crash-test dummy

Project goals

- Functional crash test dummy
- Simulate different bike-car collision scenarios
- Collect collision data

Crash-test dummy

Project goals

- Bike: ~20 km/h
- Car: 30 km/h
- Collision: rear/ side
- Bike must travel > 4m without support

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Crash-test dummy

Evolution of crash simulation: first crash 2012

Crash-test dummy

Evolution of crash simulation: March 2013

Crash-test dummy

Evolution of crash simulation: March 2014

Crash-test dummy

Evolution of crash simulation: March 2015

Crash-test dummy (2015-16)

Crash-test dummy (2016-17)

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Crash-test dummy (2016-17)

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Crash-test dummy

Project goals – this year

- Dummy re-design
- Reliable launch mechanism
  - Timing/trigger
  - Bike stabilization
- 3D Reconstruction & Visualization
- Quantification of head impact

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CUCD Organization

Project Coordinator:

Crash Dummy	Timing and Sensing	Launch System
Lead Engineer: Frei	Lead Engineer - Speirs	Lead Engineer - Petel
Shoulder	3D video reconstruction	New buggy support
Elbow	Timing System	Redesigned chain tensioners
3D print skin	Timing Motor	New crane design
Head	High speed sensing	Motor control and analysis
Neck/Spine	Head acceleration	Handlebar-fork decoupling
Pelvis	Head impact	Fine adjustment capability
Foot interface	Dummy balance	Measure bike speed

Crash Dummy

Prof. Frei

- Head redesign (1)
- Spine, neck and neck tensioner redesign (1)

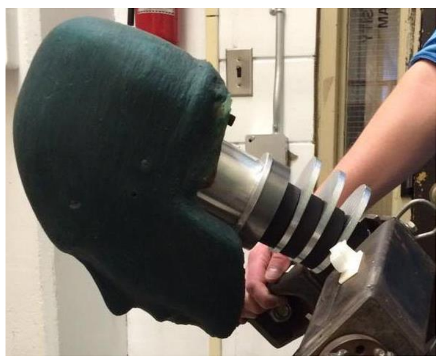
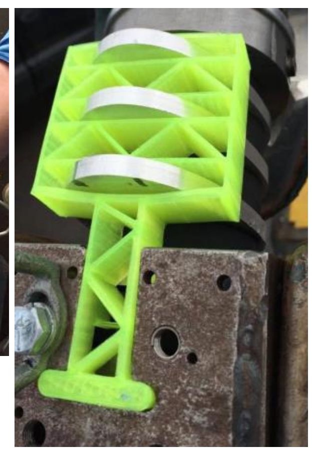
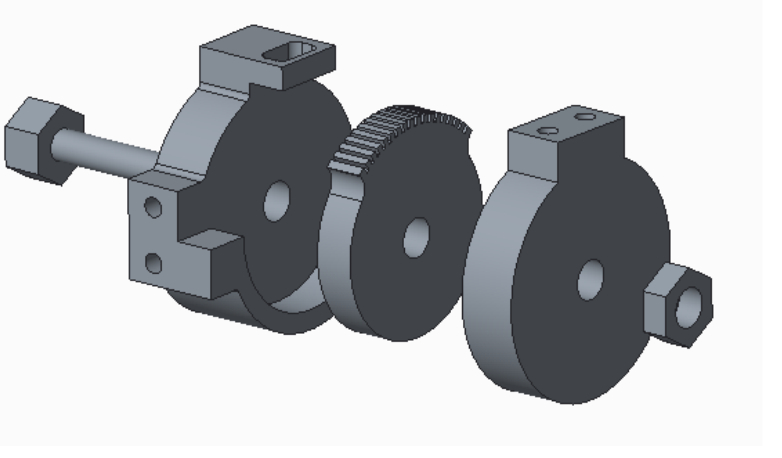


Figure 6.4: Final neck design from the 2015-2016 group with the neck brace on the right. [.3]



Crash Dummy
Prof. Frei

- Pelvis design (1)
- Elbow redesign (1)
- Shoulder redesign (1)



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Crash Dummy

Prof. Frei

- Foot pedal interface (1)
- Skin 3D printing (1)

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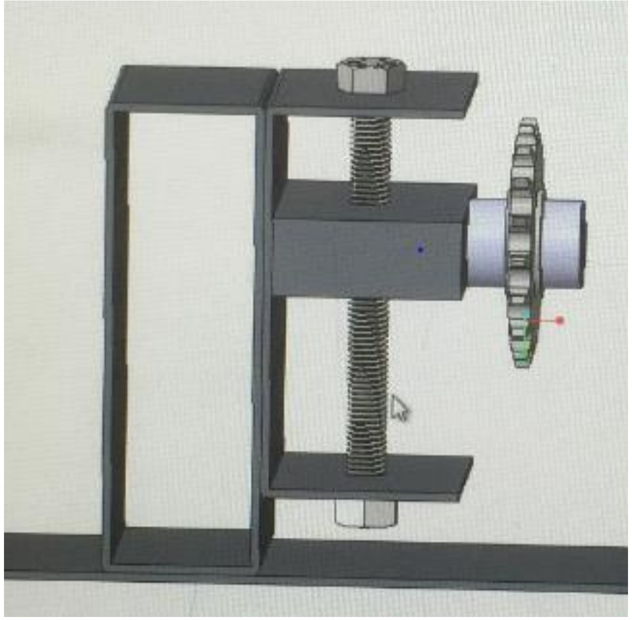
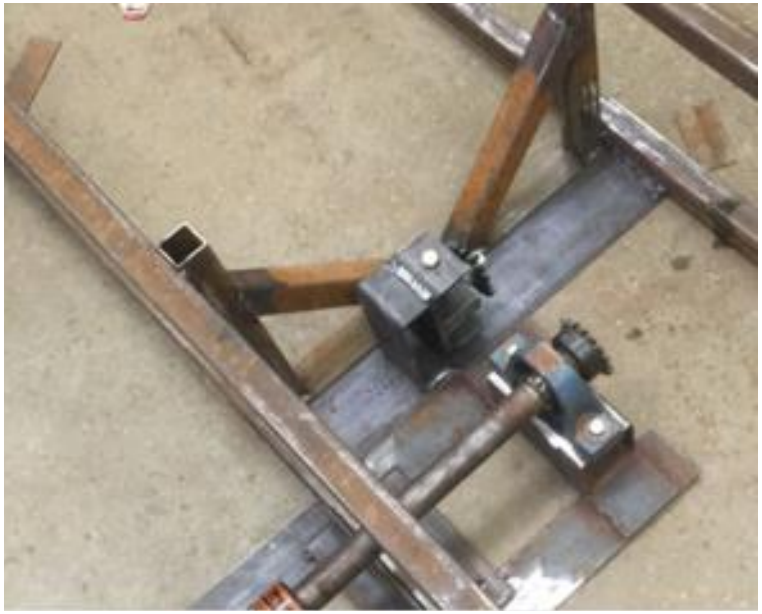
Launch System
Prof. Petel

- New buggy support concepts (1)
- Redesigned chain tensioners (1)
- New crane design (1)





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Launch System

Prof. Petel

- Motor Control and Analysis (1)
- Handlebar-fork decoupling (1)
- Fine adjustment capability on the bike/dummy support structures/ cart (1)
- Sensors to measure bike speed coming off the track (1)
- Rust strip and paint track (All)

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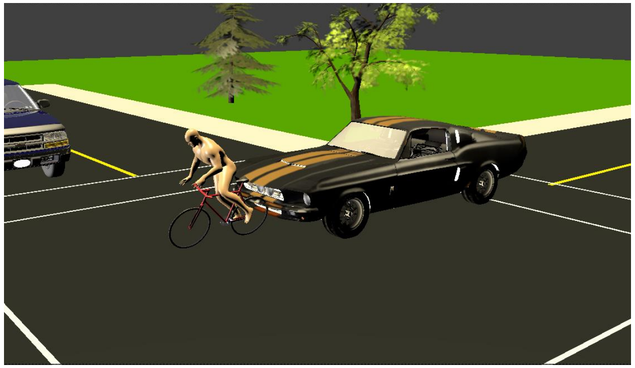
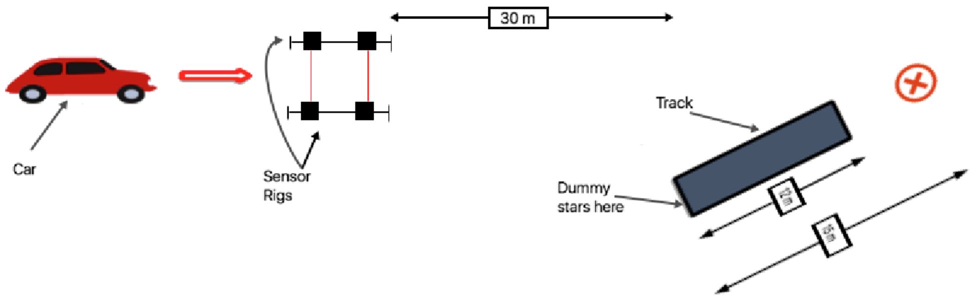
Timing and Sensing

Prof. Speirs

- 3D video reconstruction and simulation (1)
- Timing: system characterization (speed, acceleration, launch time) (1)

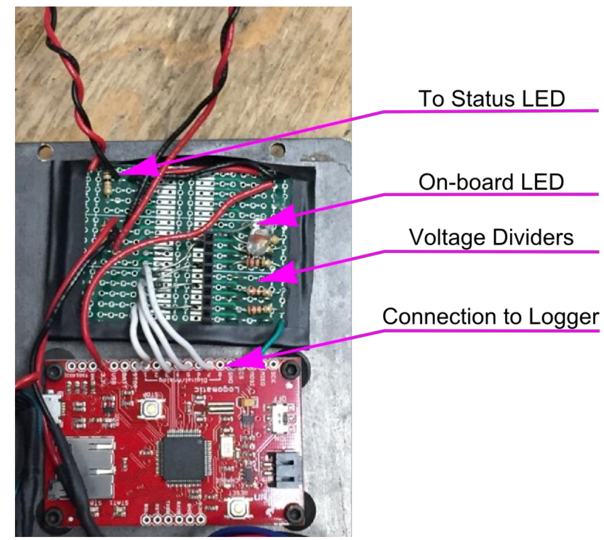


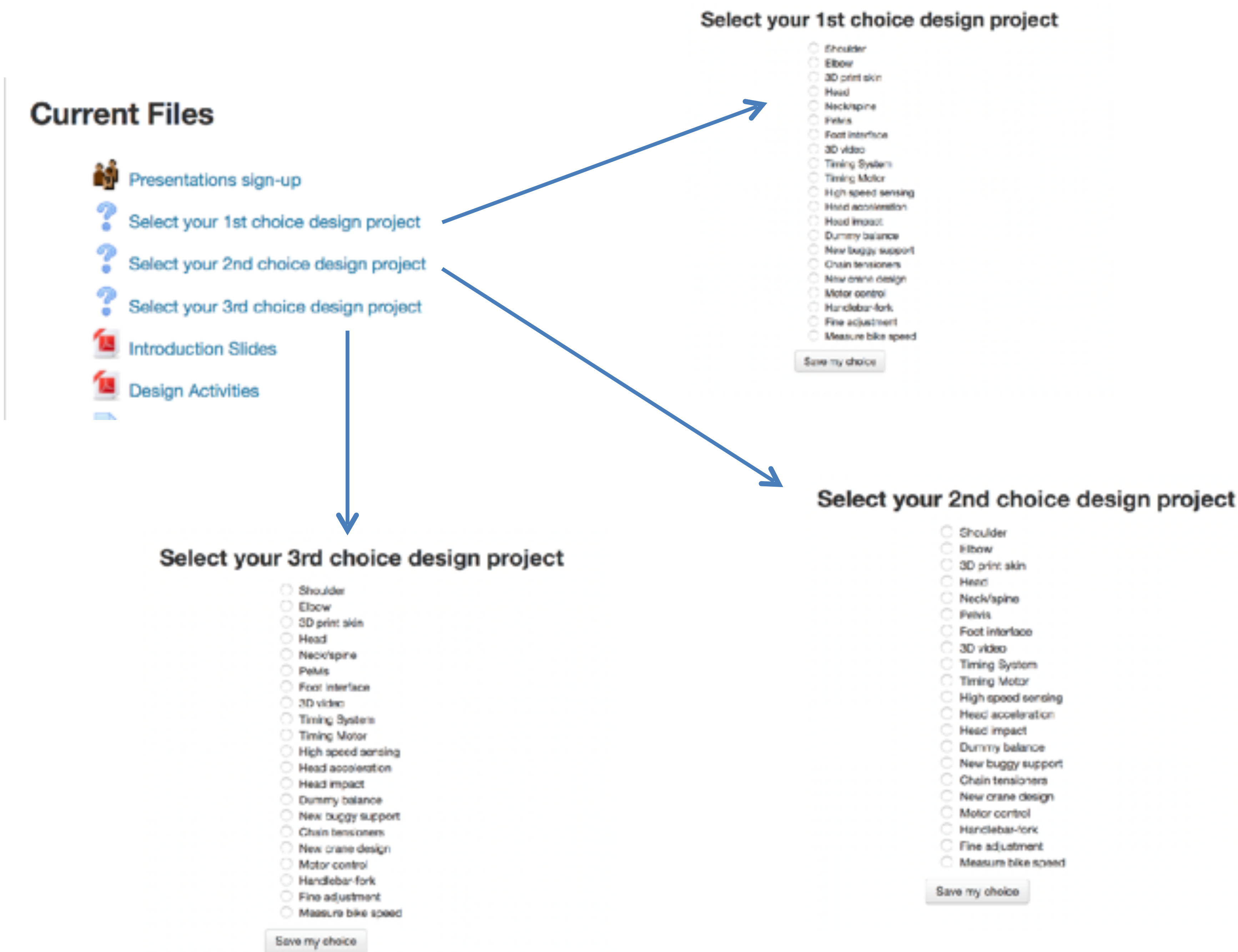


Timing and Sensing

Prof. Speirs

- Timing: motor/VFD/power analysis (1)
- High speed sensing/logging (1)
- Head acceleration measurement (1)
- Head impact assessment (1)
- Dummy and bike setup/balance (1)





Current Files
Presentations sign-up
Select your 1st choice design project
Select your 2nd choice design project
Select your 3rd choice design project
Introduction Slides
Design Activities
Select your 1st choice design project
Shoulder
Elbow
3D print skin
Head
Neck/spine
Pelvis
Foot interface
3D video
Timing System
Timing Motor
High speed sensing
Head acceleration
Head impact
Dummy balance
New buggy support
Chain tensioners
New crane design
Motor control
Handlebar-fork
Fine adjustment
Measure bike speed
Save my choice
Select your 2nd choice design project
Shoulder
Elbow
3D print skin
Head
Neck/spine
Pelvis
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Motor control
Handlebar-fork
Fine adjustment
Measure bike speed
Save my choice

CUCD Organization

Daniel Mason

Crash Dummy

Lead Engineer - Frei

- Emily Kaczmarek
- Emma Gibney
- Rohail Qureshi
- Sinthujan Rajadurai
- Hussien Bashar
- Amanda Skawinski
- Trenton Lang

Timing and Sensing

Lead Engineer - Speirs

- Daniel Mason
- Matthew Drummond
- Calvin Ho
- Connor McGuirk
- Gregory Olive
- Samantha Phillips
- Marco Bottega

Launch System

Lead Engineer - Petel

- James Nugent
- Steven Donders
- Christopher Millbank
- Tyler Moore
- Connor Myers
- Gregory Gravelle
- Adel Abu Hassan

Project Coordinator

- Public face of the project
- Funding applications
- Team budget
- Liaise with outside people/organizations (police, media, Dept. University Safety)
- Smaller design project

Team Coordinators

- Coordinate team efforts
- Integration within and with other teams
- Present weekly update of team
- Ensure specs, drawings etc. properly stored
- Slightly smaller design project

Scheduled Meetings

- Meetings begin at <u>8:35</u>
- Arrive on time (performance marks)
- Act "professionally"
  - i.e. this is your first engineering job

Project Room

- 2328 ME
- You MUST complete online safety (EHS) training module for access to room
- Card access
- Keep tidy

Project Room

- 2328 ME
- THIS IS NOT A WORK SPACE
  - Light (dis)assembly work only
  - Other work: see support staff (Alex, Steve, David, Stephan)
    - ME 2230, 2342, Machine Shop

Weekly Presentations

- Each student presents once per term
- 10 min presentation
- Student's own progress
- Feedback from class (integration)
- 2-3 presentations per week
- Sign-up on cuLearn

Team Updates

- Each team will give brief update of progress
- Encouraged to use graphics
- Team coordinator is responsible but may call on individual team members

Grading

Documentation 40%

- Tech memos
- Design Report (end of fall term)
- Final Report (end of winter term)

Grading

Formal Presentations 20%

- PDR (Preliminary Design Review) (10%)
  - End of fall term
- CDR (Critical Design Review) (10%)
  - End of winter term

Grading

Performance Evaluation 40%

- 20% for each term

Ranking and score / Area of evaluation	Unacceptable	Poor	Marginal	Satisfactory	Very good	Excellent	Weight	Total (weight x score)
	1	2	3	4	5	6		
Design and technical contribution							6	
Communication							1	
Management of Resources							1	
Initiative and Commitment							1	
Attitude and team spirit							1	

Final Mark: /60

Ranking and score / Area of evaluation	Unacceptable	Poor	Marginal	Satisfactory	Very good	Excellent
	1	2	3	4	5	6
Design and technical contribution	Technical work is largely incorrect and inaccurate.	Work must be redone by others to meet standards.	Keeps a consistent quality of work but falls short of satisfactory standards.	Quality of work is generally of acceptable or good quality. Rarely added depth or quantity.	Work is of high quality and typically above standard. Occasionally added depth and quantity.	Technical work is always of exceptional quality and accuracy. Consistently more depth and quality than required.
Communication	Ineffective communicator with no effort to improve.	Skills ineffective. Makes little effort to improve.	Frequently confusing – improper use of terms, descriptions of methods and results are unclear, with little effort to clarify or improve.	Sometimes confusing but effort is made to clarify and improve.	Clear communication but with occasional errors in terminology, methods, and results. Concerted effort to improve weak areas.	Clear communication with proper use of terms, methods and results that are immediately understandable by group members, project members and external stakeholders.
Management of Resources	Little to no useful work. Takes away from the productivity of the team as a whole. No individual plan and no contribution to group plan.	Not enough useful work done in group or out. Sometimes wastes his/her time and others. Work is typically late and no consistent planning done. No plan.	Does not work well within the team, occasionally wastes team's time. Has trouble doing productive work. Some tasks completed late. Plan includes some tasks.	Is not time-efficient in working with the group, but works hard when a deadline is near. Most tasks completed on time. Plan includes all tasks but incomplete dates.	Uses time effectively in and out of group. Completes all tasks on time. Plan includes tasks and dates but interdependencies not noted.	Uses time effecitively in and out of group and works to get others to do the same. All tasks completed on or ahead of schedule. Complete plan with list of tasks, task interdependencies, dates of completion.
Initiative and Commitment	Must be constantly told what to do by supervisors and peers. Performs few if any assigned tasks.	Lets others do the work does the minimum he/she thinks is needed to get y. Performs few assigned tasks.	Tends to watch others work, but does get involved when necessary. Volunteers help only when a necessity. Performs most assigned tasks.	Gets involved enough to complete tasks. Does his/her share and volunteers for multiple tasks.	Readily accepts tasks, sometimes seeks more work. Gets involved in the project. Sometimes does more than required. A producer.	Takes initiatives to seek out work, concerned with getting the job done. Very involved with the technical project. Consistently does more than required and motivates others.
Attitude and team spirit	Negative attitude that adversely affects other members. Never participates in team or group meetings. Frequently absent without notifying Lead Engineers.	Negative attitude that adversely affects other members. Rarely participates or contributes to team or group meetings.	Negative attitude toward project and/or team. Occasionally participates in group meetings or discussion.	Neutral attitude. Always participates in team meetings. Contributes moderately to the discussions and team effort.	Positive attitude toward project and the team. Actively involved in team activities. Shares knowledge with team members. Communicates design updates with other team members when requested.	Positive and professional attitude that provides a positive influence to other team members. Organizes team meetings. Shares knowledge with team members. Proactively communicates design updates with team members.

Milestones

Fall crash test		October 6
Proposal (tech memo) *		October 13
Tech memo – Design Inputs	*	October 20
Tech memo – Design Outputs	*	November 13
Design Report	*	December 8
Design Freeze		December 8
Pre-test		Early March
Final Test		Late March

* Deliverable

Funding

Seed funding from Department

- $2000

CUESEF: www.cuesef.carleton.ca

- Capital purchases, including for 4th year project
- Requires proposal

CSES: cses.carleton.ca/services/sgf

- Smaller purchases
- Requires proposal

cuLearn and Windows Share Drive

- Windows Domain Shared Drives
  - There is a network share for each of the nine projects as follows:
    \\arrow\2017cucd
  - These shares can mapped from non-lab computers by using the IP address 134.117.71.23 instead of the server name arrow.

    Archives: \
    \134.117.70.29\projectarchives\2015projects\2015cucd\
    \\134.117.70.29\projectarchives\2014projects\2014cucd\