EG 2401(a) Engineering Professionalism

Lecture 1

Sem I, AY 2021-22

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Aug/Sep 2021

The flamethrower drone will soon be a thing you can buy

By Sean Hollister | Today at 9:15am SST | 5 comments

© TheVerge

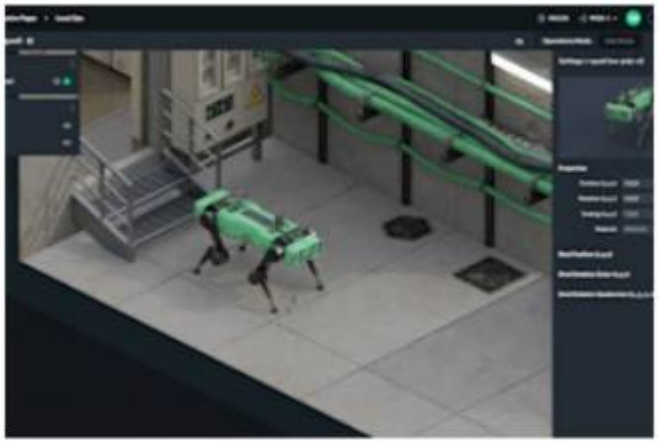
Security

Oakland bans city use of facial recognition software

It's now the third US city to do so.

By C. Fisher, 11h ago

© Engadget



Watch a Boston Dynamics robot herd sheep in New Zealand

Robotics company Rocos shows how Spot might advance precision agriculture.

By C. Fisher, 22m ago

© Engadget

Spot the robot is reminding parkgoers in Singapore to keep their distance from one another

By James Vincent | May 8 | 16 comments

© TheVerge


ROCOS
A robot sheepdog? 'No one wants this,' says one shepherd
BY JAMES VINCENT

© TheVerge

Yep, human workers are listening to recordings from Google Assistant, too

By James Vincent | July 11 | 66 comments

© TheVerge

Security

Surprise: People are listening to your Google Assistant queries

By C. Fisher, 9h ago

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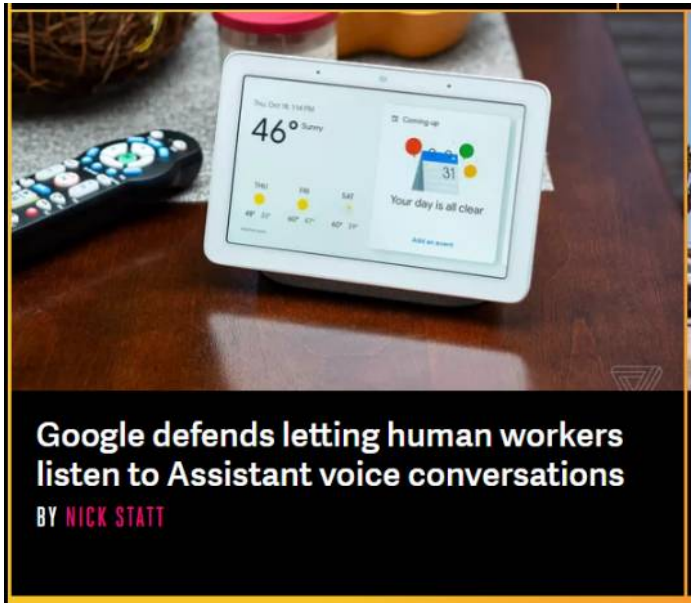

TOPIC 1 – Introduction (Issues)

- **THL1.1 - Some Background & Preliminaries**
- **THL1.2 - Why Study Engineering Ethics?**
- **THL1.3 - Origins of Ethical Thought – Some Pertinent Points**
- **THL1.4 - Ethics Problems -- Like Engineering Design Problems? How so?**
- **THL1.5 - Illustrative Cases (Homework Reading!!!)** ☺☺
- **THL1.6 - Summary (I)**

Reference Reading: *Fleddermann* 4th Ed Chapter 1

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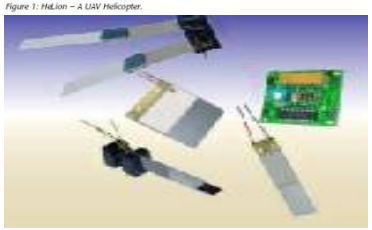
How many of us see it --- on Engineering…

"an Engineering career will not be a passive one… engineers make new happenings possible…"

Figure 1: HeLion – A UAV Helicopter.



***Prof. T. H. Lee, B.A. (Hons I) Cambridge; M.Engrg NUS; Ph.D. Yale;**
Centre for Intelligent Control, Dept of ECE, National Univ of Singapore
Dy Editor-in-Chief, IFAC Mechatronics Int Jnl

NUS National University of Singapore

Warblr can identify that bird just by hearing its song

by Timothy J. Seppala | @timseppala | 1hr ago

Technology can be pretty wonderful sometimes. Case in point: Warblr, an app that uses sound recognition tech and your phone's GPS signal to identify birdsongs. The application first pinpoints where you are (it'll debut in the United Kingdom), and narrows the results by what types of fowl are common to the area, according to its Kickstarter page. Then, after making the ID, it presents the most likely suspects. Pretty simple, yeah? The folks behind the app say that one of the intentions is to add geo-tracking to, well, *track* what species are being found where -- useful for the likes of zoologists and ecologists to monitor migration patterns, for one.

NUS National University of Singapore

Engineers often open new vistas... and largely form the cornerstone for the basis for potential to make our material life even more pleasant...

"... What is this life, so full of care... that we have no time, to stand & stare?... [maybe now with technology, we now sometimes can... ☺☺...]"

Wounded turtle can return to the ocean thanks to a 3D-printed beak

by Mariella Moon | @mariella_moon | 17hrs ago

Look, we know this sea turtle's prosthetic beak has a tragic backstory, but it sure makes the reptile look like it has a future as a badass pizza-loving mutant. According to *3D Printing Industry*, Turkish animal rescuers found it almost lifeless at sea, after a boat propeller shaved off a huge part of its snout. It escaped the clutches of death thanks to those kind folks, but a turtle that has to be hand-fed can never survive back in the wild. That's why the organization contacted 3D printing service provider BTech Innovation, which took the turtle's CT scans to create a beak that would fit it perfectly.

READ THE FULL STORY | 46 COMMENTS | SHARE

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Engineers often open new vistas... and largely form the cornerstone for the basis for potential to make our material life even more pleasant...

"... What is this life, so full of care... that we have no time, to stand & stare?... [maybe now with technology, we now sometimes can... ☺☺...]"

GSMArena smartphone shopping guide: June 2014

GSMArena team, 09 June 2014.

Comments (74)

Pages: 1 2 3 4 5 6 7 8 » 1. Introduction

Tags: Android, Windows Phone, iOS

Introduction

We intentionally delayed this edition of our phone shopping guide, waiting for all flagships to come out. With the last one out and reviewed, time to see how the market evolved since our last edition in March.

Engineers often open new vistas… and largely form the cornerstone for the basis for potential to make our material life even more pleasant…

© GSMArena

Check out our latest wearable buyer's guide

by Jon Turi | @jonturi | 6hrs ago

Since we first posted our buyer's guide this summer, one of the most awaited wearables, the Moto 360, was released and is now starting to encircle the wrists of Android users everywhere. While it did have some battery woes at launch, recent software updates have addressed the issue, keeping this definitively watch-like device as one of our top selections this year. It's obviously not the only quantifying and notifying option out there, so for a quick refresher on some of our other top picks you can head to the gallery below. You can also check out our full listing of phones, laptops, tablets and wearables that could help flesh out your holiday wishlist. There's still more to come over the next few months, and we'd love to hear your input (in the comments below) on what items you'd like to see included.

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NUS National University of Singapore

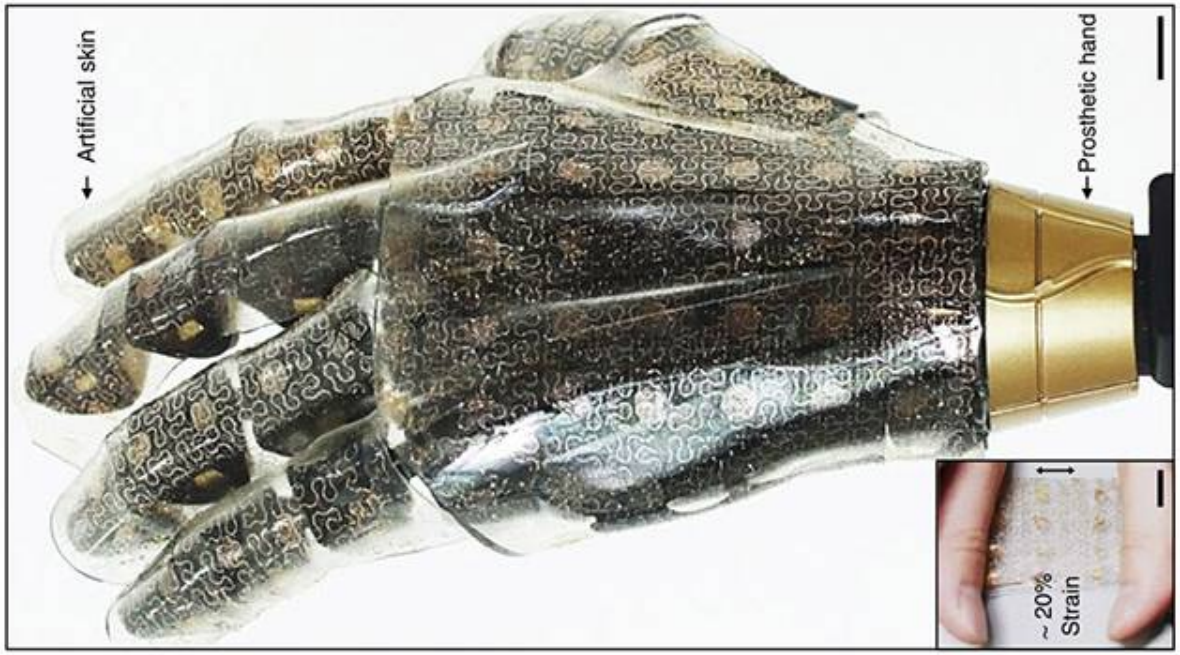
As promised, a paralyzed man did indeed kick off today's World Cup festivities by wearing a mind-controlled robotic exoskeleton. Juliana Pinto, a 29-year-old paraplegic, was one of eight patients chosen for the opening ceremony after extensive training in a lab in Sao Paulo. Dr. Miguel Nicolelis, a neuroscientist from Duke University who's the leader of the Walk Again Project, was ecstatic, proclaiming on Twitter "We did it!!!" Though the kick, as you can see above, was just a simple nudge to the ball, it's actually extremely complicated. Nicolelis told the AFP news agency that it's "the first time an exoskeleton has been controlled by brain activity and offered feedback to the patients," and that "doing a demonstration in a stadium" has never been done before. Unfortunately, it seems this momentous occasion wasn't captured on as many television networks as the rest of the opening ceremony, which strikes us as a crying shame. Hit the source links for more information on this miraculous innovation and have a peek at a fan-captured video of the event after the break.

© Engadget

Yet more good from engineers... just another one of *countless* more examples...

Stretchable artificial skin can give prosthetics the sense of touch

by Mariella Moon | @mariella_moon | 14hrs ago



Some prosthetic limbs are so advanced they can be controlled by the brain, but no bionic arm or leg will ever be truly be life-like until they have "skin" that can feel. This new artificial skin developed by a team of American and Korean researchers, for instance, has a dense network of sensors made of silicon and gold that mimic the sensitivity of real skin. The amount of sensors present is important, because as Roozbeh Ghaffari (one of the researchers, who also works for MC10, the same startup behind those Biostamp stickers) said: "If you have these sensors at high resolution across the finger, you can give the same tactile touch that the normal hand would convey to the brain."

© Engadget

Yet more good from engineers... just another one of *countless* more examples...

Airdog drone serves as your loyal action sports cameraman

BY JAMES TREW @ITSTREW • JUNE 16TH 2014, AT 5:00 AM ET

The battle in the skies this week is the autonomous action-sports drone apparently. Why? Because, what if you want to be the star in your as yet un-made aerial epic? With a regular drone that's a tricky one. You *could* film yourself, as you stand flying the drone, but where's the fun in that? Airdog is a quadcopter drone that follows you, using GPS and movement tracking to keep up as you get down (the slope, or whatever). Action camera selfie videos are cool and all, but wouldn't an epic aerial shot following you carving through fresh powder snow, or riding that killer wave, or heck, even scuba diving be so much better? Airdog promises exactly that. And more.

SOURCE: Airdog, Kickstarter

空撮ドローンではない飛ぶカメラLily 予約開始 ^o^ 自動追尾や回り込み対応、浮く防水仕様

2015年05月14日 15時42分 ■ BY ITTOUSAI

米国のスタートアップ企業 Lily Robotics が、空飛ぶカメラ Lily の購入予約受付を開始しました。

Lily は空中に放り投げれば、あとは自動的にユーザーを追いかけてフルHD動画や12MP写真を撮影してくれる「カメラ」。

いわゆる空撮ドローンに分類される製品ですが、開発者はあくまでカメラの再発明であって、操作して飛ばすことが主眼の「ドローン」ではないと表現しています。

© Engadget (Japanese)

Lily カメラ

すべての写真を見る　8 枚

This drone follows you down the trail after you toss it up in the air

by Billy Steele | @wmsteele | May 12th 2015 at 10:41 pm

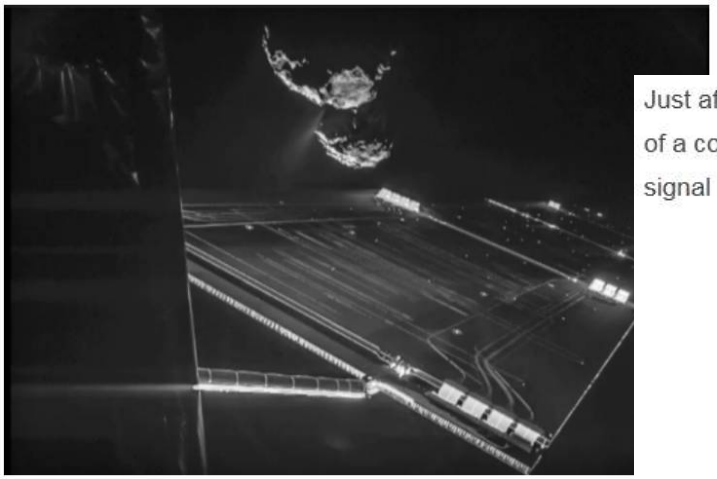
© Engadget

Aerial footage is a nice way to capture those action sports endeavors, and it's even better if you can fit the gear in your backpack. Lily ticks those boxes, and all you have to do to launch it is toss it up in the air. Once airborne, the camera UAV will follow you down the slopes or along the trail thanks to a tracking device that you wear on your wrist (or stuff in a pocket, we'd surmise). It's a similar setup to the Airdog we saw on Kickstarter last year. On board, the drone packs a camera capable of 12-megapixel stills, 1080p footage at 60 frames per second and 720p video at 120 fps. Those optics offer a 94-degree filed of view and the settings can be dialed in with a smartphone app. You can take the thing out on the water too, as the drone is waterproof and floats -- should it land in the rapids.

Humanity just landed a spacecraft on a comet

After 10 long years on Rosetta's back and a 7-hour fall toward its target, the Philae lander anchored itself to the surface of a comet

By Elizabeth Lopatto on November 12, 2014 11:06 am *Email* *@mslopatto*



Share on Facebook | Tweet (540) | Share | Share (55) | Pin (3)

Just after 11AM ET, the European Space Agency's Philae lander made contact with th
of a comet. The 250-pound probe settled on a patch of the 2.5-mile-long comet and se
signal home, ESA said.

Philae left Earth a decade ago, hitching a ride on ESA's Rosetta orbiter. About seven hours ago, Rosetta released the washing-machine-sized probe, and it began to fall toward its target, a comet called 67P/Churyumov–Gerasimenko. Though the landing site was selected to ensure minimal debris, it was possible that Philae wouldn't stick the landing — especially after the head Rosetta lander, Stephan Ulamac, said yesterday that Philae's thrusters, meant to stabilize the craft as it landed, might not work.

"You have all heard Philae has landed," says Jean-Jacques Dordain, ESA's director general. "This is a big step for human civilization. This is terrestrial intelligence that makes a difference."

The harpoons meant to anchor Philae did not shoot, so although we know for sure it's on the surface, it may not stay there, ESA officials said on the livestream. The team is now looking at

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The Big Picture: A massive typhoon as seen from orbit

by Jon Fingas | @jonfingas | October 15th 2014 at 9:13 pm

No, a black hole didn't suddenly open up on the Earth's surface. That's Vongfong, a gigantic storm (then a super typhoon) that has been causing chaos in the Asia-Pacific region for much of October. NASA astronaut Reid Weisman posted this dramatic photo as the International Space Station orbited overhead on the morning of October 9th, when Vongfong was getting close to Okinawa. It had been downgraded to "just" a category 4 super typhoon by then, but that still made it both enormous and dangerous -- the eye alone was about 30 miles across, and it had sustained winds of nearly 150MPH. As beautiful as this orbital view may be, it's comforting to know that Vongfong has since weakened to a tropical storm and isn't posing nearly as much of a threat.

© Engadget

"But lest we forget…beware, the sinking (boasted of as being "unsinkable") of the Titantic…etc…"

… engineers [need to] realize how their technical work has far reaching impacts on society. The work of engineers can affect public health and safety and can influence business practices and even politics.

***Fleddermann* 4th Ed Chapter 1, page 2**

Space Shuttle *Challenger* disaster

© Wikipedia

From Wikipedia, the free encyclopedia

Coordinates: 28°38'24"N 80°16'48"W

The **Space Shuttle *Challenger* disaster** occurred on January 28, 1986, when Space Shuttle *Challenger* (mission STS-51-L) broke apart 73 seconds into its flight, leading to the deaths of its seven crew members. The spacecraft disintegrated over the Atlantic Ocean, off the coast of Cape Canaveral, Florida at 11:38 EST (16:38 UTC). Disintegration of the vehicle began after an O-ring seal in its right solid rocket booster (SRB) failed at liftoff. The O-ring failure caused a breach in the SRB joint it sealed, allowing pressurized hot gas from within the solid rocket motor to reach the outside and impinge upon the adjacent SRB attachment hardware and external fuel tank. This led to the separation of the right-hand SRB's aft attachment and the structural failure of the external tank. Aerodynamic forces broke up the orbiter.

The crew compartment and many other vehicle fragments were eventually recovered from the ocean floor after a lengthy search and recovery operation. The exact timing of the death of the crew is unknown; several crew members are known to have survived the initial breakup of the spacecraft. The shuttle had no escape system, and the impact of the crew compartment with the ocean surface was too violent to be survivable.

The disaster resulted in a 32-month hiatus in the shuttle program and the formation of the Rogers Commission, a special commission appointed by United States President Ronald Reagan to investigate the accident. The Rogers Commission found NASA's organizational culture and decision-making processes had been key contributing factors to the accident.[1] NASA managers had known contractor Morton Thiokol's design of the SRBs contained a potentially catastrophic flaw in the O-rings since 1977, but failed to address it properly. They also disregarded warnings (an example of "go fever") from engineers about the dangers of launching posed by the low temperatures of that morning and failed to adequately report these technical concerns to their superiors.

What Rogers did not highlight was that the vehicle was never certified to operate in temperatures that low. The O-rings, as well as many other critical components, had no test data to support any expectation of a successful launch in such conditions. Bob Ebeling from Thiokol delivered a biting analysis: "[W]e're only qualified to 40 degrees ...'what business does anyone even have thinking about 18 degrees, we're in no man's land.'"[2]

Space Shuttle *Challenger* disaster

Space Shuttle *Challenger*'s smoke plume after its in-flight breakup, resulting in its destruction and the deaths of all seven crew members.

Date	January 28, 1986
Time	11:39:13 EST (16:39:13 UTC)
Location	Atlantic Ocean, off the coast of central Florida
Outcome	Grounding of the Space Shuttle fleet for nearly three years during which various safety measures, solid rocket booster redesign, and a new policy on management decision-making for future launches were implemented.

Casualties

Francis R. Scobee, Commander
Michael J. Smith, Pilot
Ronald McNair, Mission Specialist
Ellison Onizuka, Mission Specialist
Judith Resnik, Mission Specialist
Greg Jarvis, Payload Specialist
Christa McAuliffe, Payload Specialist

Inquiries Rogers Commission

Challenger Disaster Live on CNN - YouTube

www.youtube.com/watch?v=j4JOjcDFtBE ▾

Jul 25, 2007 - Uploaded by Deltaforce5000tm

January 28th, 1986 at 11:39am EDT - The Space Shuttle **Challenger** Explodes on its 10th flight during mission ...

Bhopal disaster

© Wikipedia

From Wikipedia, the free encyclopedia

Coordinates: 23°16′51″N 77°24′38″E

> The **neutrality of this article is disputed**. Relevant discussion may be found on the talk page. Please do not remove this message until the dispute is resolved. *(December 2012)*

The **Bhopal disaster**, also referred to as the **Bhopal gas tragedy**, was a gas leak incident in India, considered the world's worst industrial disaster.[1] It occurred on the night of 2–3 December 1984 at the Union Carbide India Limited (UCIL) pesticide plant in Bhopal, Madhya Pradesh. Over 500,000 people were exposed to methyl isocyanate (MIC) gas and other chemicals. The toxic substance made its way in and around the shanty towns located near the plant.[2] Estimates vary on the death toll. The official immediate death toll was 2,259. The government of Madhya Pradesh confirmed a total of 3,787 deaths related to the gas release.[3] Others estimate 8,000 died within two weeks and another 8,000 or more have since died from gas-related diseases.[4][5][6] A government affidavit in 2006 stated the leak caused 558,125 injuries including 38,478 temporary partial injuries and approximately 3,900 severely and permanently disabling injuries.[7]

The cause of the disaster remains under debate. The Indian government and local activists argue slack management and deferred maintenance created a situation where routine pipe maintenance caused a backflow of water into a MIC tank triggering the disaster. UCC contends water entered the tank through an act of sabotage.

The owner of the factory, UCIL, was majority owned by Union Carbide Corporation (UCC), with Indian Government-controlled banks and the Indian public holding a 49.1 percent stake. In 1989, UCC paid $470m ($907m in 2014 dollars) to settle litigation stemming from the disaster. In 1994, UCC sold its stake in UCIL to Eveready Industries India Limited (EIIL), which subsequently merged with McLeod Russel (India) Ltd. Eveready Industries India, Limited, ended clean-up on the site in 1998, when it terminated its 99-year lease and turned over control of the site to the state government of Madhya Pradesh. Dow Chemical Company purchased UCC in 2001, seventeen years after the disaster.

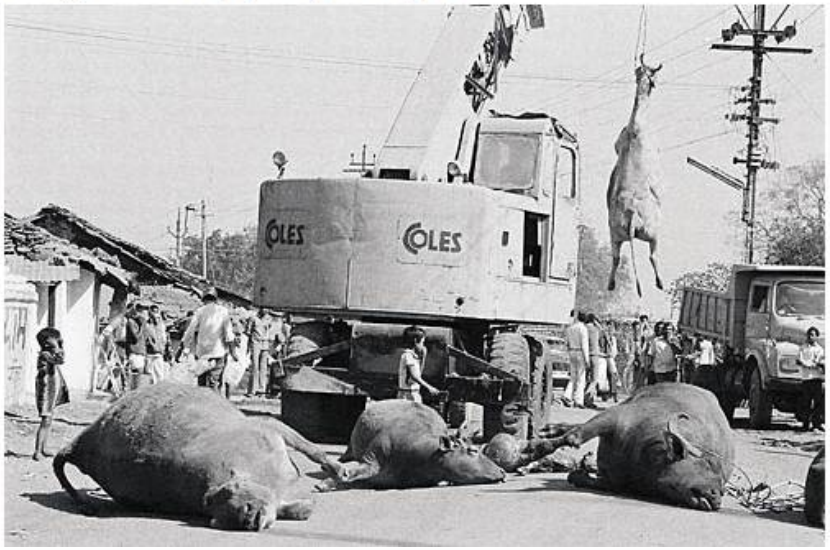
Bhopal disaster

Bhopal memorial for those killed and disabled by the 1984 toxic gas release

Date	2 December 1984– 3 December 1984
Location	Bhopal, Madhya Pradesh
Coordinates	23°16′51″N 77°24′38″E
Also known as	Bhopal gas tragedy
Cause	Gas leak from Union Carbide India Limited storage tank
Deaths	At least 3,787; over 16,000 claimed
Injuries	At least 558,125

A respectful depiction... but which would make clear (on careful thinking) that the destruction was deeply devastating... [this case will be discussed in-depth by Prof K.G. Neoh in later lectures]

Bhopal gas tragedy in pics



At the time, UCIL was the Indian subsidiary of the US company Union Carbide Corporation (UCC), itself now a subsidiary of Dow Chemical Company.

PHOTO: India Today Archives

114 46
DO YOU LIKE THIS PHOTO?

Comment

ARTICLE

This 'smart' Barbie is raising concerns over children's privacy

By James Vincent on March 16, 2015 09:48 am

Privacy campaigners are demanding that toymaker Mattel halts the production of Hello Barbie, a Wi-Fi enabled doll that records children's conversations to learn about their likes, dislikes, and ambitions. Mattel says the doll's voice-recogni...

© TheVerge

Hello Barbie has some career advice for your child

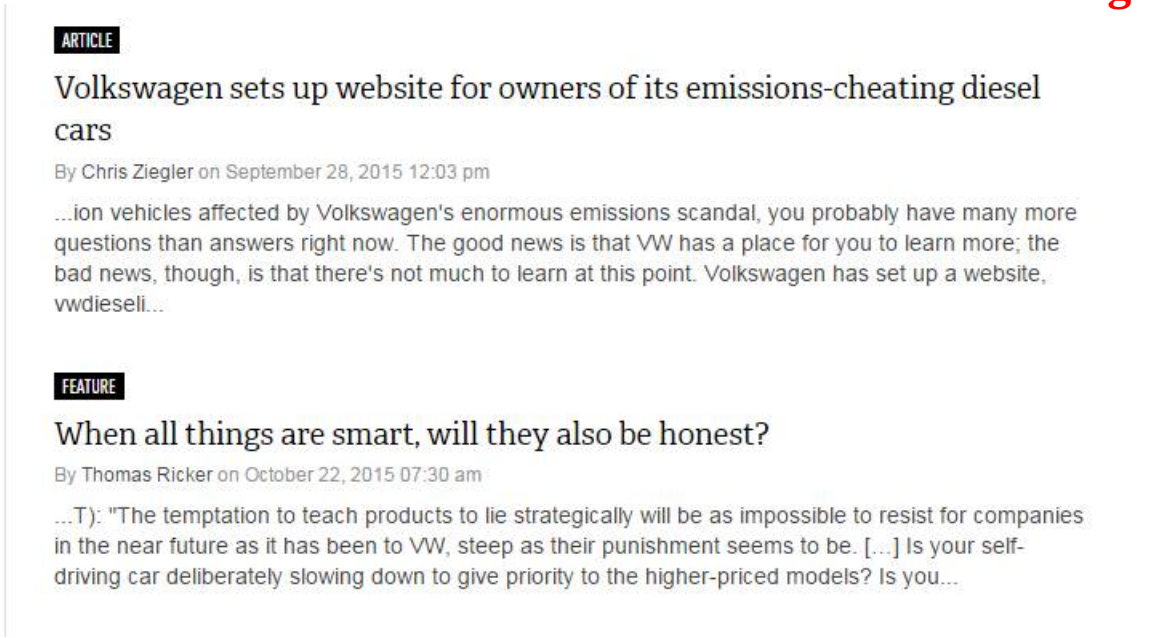
There's a new Barbie on the block. She's chatty and she comes with a charging station. She's dressed in a cropped, metallic leather jacket, dark skinny jeans and a white sweater vest with the word "HE...

2 months ago

© Engadget

When all things are smart, will they also be honest? …

© TheVerge



ARTICLE

Volkswagen sets up website for owners of its emissions-cheating diesel cars

By Chris Ziegler on September 28, 2015 12:03 pm

...ion vehicles affected by Volkswagen's enormous emissions scandal, you probably have many more questions than answers right now. The good news is that VW has a place for you to learn more; the bad news, though, is that there's not much to learn at this point. Volkswagen has set up a website, vwdieseli...

FEATURE

When all things are smart, will they also be honest?

By Thomas Ricker on October 22, 2015 07:30 am

...T): "The temptation to teach products to lie strategically will be as impossible to resist for companies in the near future as it has been to VW, steep as their punishment seems to be. [...] Is your self-driving car deliberately slowing down to give priority to the higher-priced models? Is you...

THL1.1 - Some Background & Preliminaries

NUS National University of Singapore

engadget Sections

6h

Gadgetry

Furby gets smarter, but it's still pretty damn creepy

Just look into its LCD eyes.

By B. Steele, 6h ago

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TECH ARTIFICIAL INTELLIGENCE FIRST CLICK

0 COMMENTS

First Click: Deep learning is creating computer systems we don't fully understand

July 12th, 2016

By James Vincent on July 12, 2016 07:30 am @jjvincent

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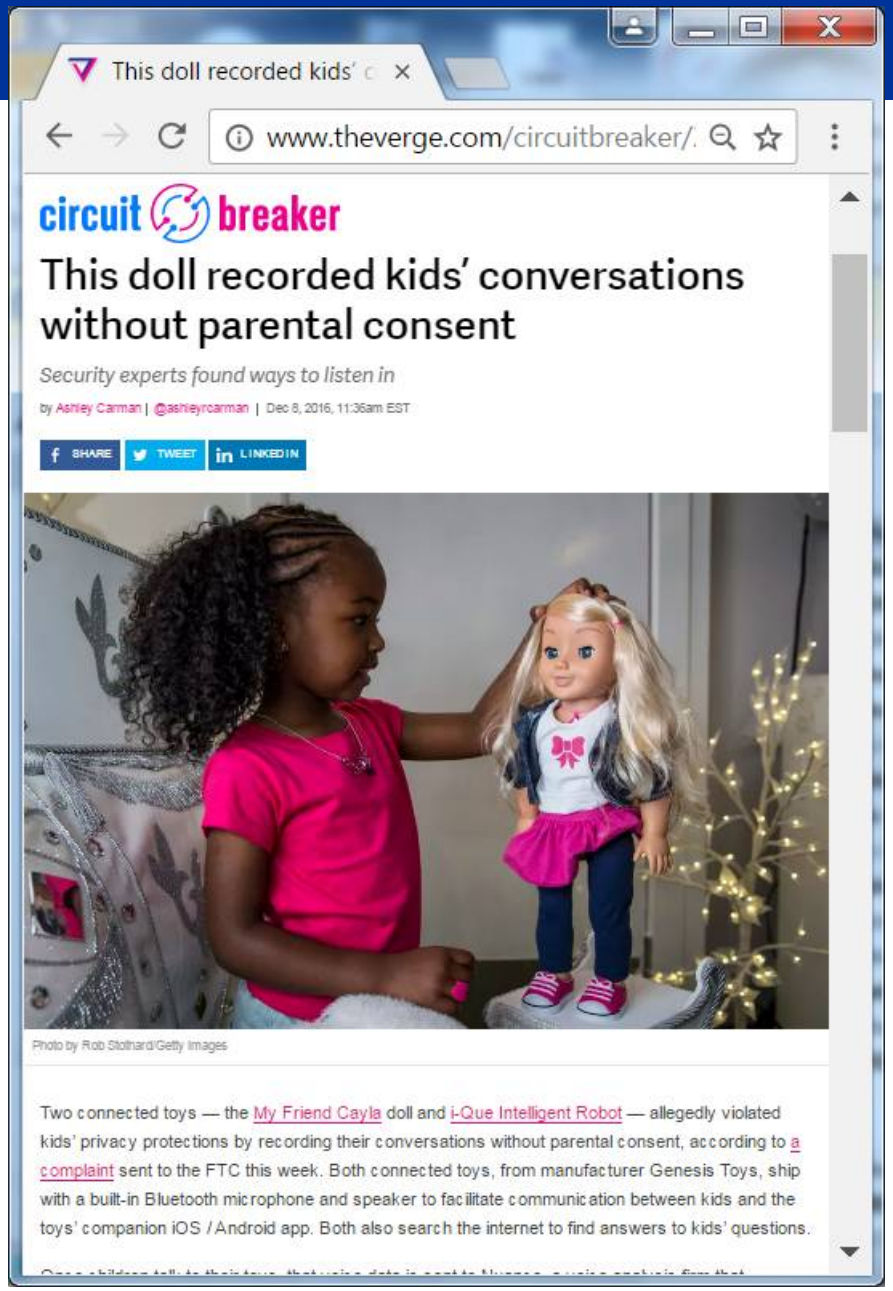
This doll recorded kids' c
www.theverge.com/circuitbreaker/.
circuit breaker
This doll recorded kids' conversations without parental consent
Security experts found ways to listen in
by Ashley Carman | @ashleyrcarman | Dec 8, 2016, 11:36am EST
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TWEET
LINKEDIN
Photo by Rob Stothard/Getty Images
Two connected toys — the My Friend Cayla doll and i-Que Intelligent Robot — allegedly violated kids' privacy protections by recording their conversations without parental consent, according to a complaint sent to the FTC this week. Both connected toys, from manufacturer Genesis Toys, ship with a built-in Bluetooth microphone and speaker to facilitate communication between kids and the toys' companion iOS / Android app. Both also search the internet to find answers to kids' questions.

© TheVerge

Google begins removing personal medical records from search results

by Amar Toor | June 23 | 1 comment

© TheVerge

Politics

More states join lawsuit to keep 3D-printed gun plans off the internet

And the temporary restraining order has been extended until August 28th.

By D. Lumb, 10h ago

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Closer at hand… here, our [my] own work…
yours too, now & in the future as engineers…

… engineers [need to] realize how their technical work has far reaching impacts on society. The work of engineers can affect public health and safety and can influence business practices and even politics.

***Fleddermann* 4th Ed Chapter 1, page 2**

Key results in adaptive and predictive control

A. Implicit Function Based Control

In nonlinear control literature, it is not easy to control a non-affine systems, because the output depends nonlinearly on the input.

Control design for

$$affine\ systems: y(k+1) = f(y(k)) + g(y(k))u(k)$$
$$--feedback\ linearization$$
$$nonaffine\ systems: y(k+1) = f(y(k), u(k))$$
$$--how\ to\ find\ an\ input\ u(k)??$$

Implicit function theorem method has been first developed in (Goh and Lee, 94), to identify the existence of an ideal control for adaptive control design.

Discrete Nussbaum Gain

Control direction: $the\ sign\ of\ \partial f(x,u)/\partial u$, "+" or "−"

$--$ *the direction the control operates*

The control direction is normally required to be known for adaptive and neural network control.

In the absence of control direction, how to design adaptive control?

To tackle this problem, the Discrete time Nussbaum Gain, $N(x(k))$, has been first developed in (Lee, 86) for discrete-time adaptive control.

Discrete Nussbaum Gain N(x(k)):

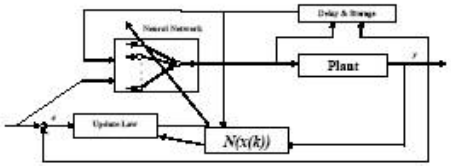
$$N(x(k)) = \sup\{x(k)\} \varepsilon(x(k)),\ S_N(x(k)) = \sum_{k'=0}^{k} N(x(k'))\Delta x(k')$$

It adapts by searching alternately with:

$$\sup \frac{1}{x(k)} S_N(x(k)) = +\infty, \inf \frac{1}{x(k)} S_N(x(k)) = -\infty$$

Controlling non-affine system with unknown control direction

Develop Implicit Function and Discrete Nussbaum Gain together in neural network (NN) control, as shown below:



To deal with external disturbance, a deadzone can be used in the update law with a threshold value λ. Using the proposed adaptive NN control, the main results are summarized as follows:

Theorem (Yang, Ge, ., Lee, 2008):

All closed-loop signals are guaranteed to be semi-globally uniformly ultimately bounded, the discrete Nussbaum gain $N(x(k))$ will converge to a constant, and the tracking error $e(k) = y(k) - y_d(k)$ satisfies $\lim_{k\to\infty} |e(k)| \le \lambda$ with $\lambda = \lim_{k\to\infty} |\varepsilon(x(k))|$.

B. Delay Compensation for Input-delay Systems via Predictive Control Design

Input delay phenomena arise from practical control problems in many processes such as chemical reaction and remote communication. A system with input delay implies that the control input will not affect the system once after its generation.

Numerous techniques are available in controller design for linear systems; However, for nonlinear systems with constant input delay, simple and feasible methods are not commonly seen. A predictive control scheme is proposed here for both linear and nonlinear systems. **The central idea is that the control signal is constructed based on the prediction of the state in the future rather than on the current state. Its performance depends on the prediction accuracy.**

Consider a general class of nonlinear system with constant input delay L

$$\dot{x}(t) = f(x(t), u(t-L)).$$

Step 1: Set $u^*(t) = u(t-L).$

Step 2: Design controller for the delay free system

$$u^*(t) = g(x(t)) = u(t-L).$$

Step 3: Use the predicted state to construct the control signal for the input-delay system.

$$u(t) = g(\hat{x}(t+L))$$

- Analytical solution to the system available → Perfect prediction
- Analytical solution to the system unavailable → Numerical scheme with high accuracy

Theorem (Xiang, Cao, Wang & Lee, 2008):

Consider a nonlinear input-delay system

$$\dot{x}(t) = f(x(t), u(t-L)),\ y(t) = h(x(t)),\ t \ge t_0$$

Using predictive controller produced by the above 3 steps, bounded tracking error between the system output and reference signal can be achieved under the following 2 assumptions:

Assumption 1: The prediction error is bounded

$$\|x(t) - \hat{x}(t)\| \le \varepsilon, \quad \forall t \ge t_0$$

Assumption 2: Given any two states $x(t)$ and $\hat{x}(t)$, there exists a constant $\gamma > 0$ such that

$$\|f(x(t), u) - f(\hat{x}(t), u)\| \le \gamma \|x(t) - \hat{x}(t)\|$$

Furthermore, perfect tracking can be achieved if the prediction error is zero.

Selected references:

1. Q.G. Wang, T.H. Lee and K.K. Tan (1998), Finite spectrum assignment for time-delay systems, Springer, London.
2. C. Xiang, L.L. Cao, Q.G Wang and T.H. Lee, A general framework for delay compensation for input-delay systems via predictive control design. (2008; under review)

Recent developments in Advanced Control Systems

A. Development of Piezoelectric Actuator for Intra-Cytoplasmic Sperm Injection (ICSI) Application

What and why ICSI

- ICSI is an artificial insemination method where fertilization is achieved by injection of one sperm directly into the cytoplasm of an oocyte (egg cell).
- ICSI addresses the issue of male infertility.
- It can help increasing birth rate in Singapore.

ICSI Procedure

A. Captured of sperm by the injection pipette
B. Penetration of zona pellucida
C. Penetration of oolemma
D. Positioning of pipette inside the cytoplasm
E. Expulsion of sperm to the cytoplasm
F. Withdrawal of injection pipette from the oocyte

Why Piezo-Assisted ICSI

- Imprecise penetration by manual operation
- Inconsistent stress on the oocyte by operator
- Vibration and deformation of oocyte with manual injection

Experimental Setup

Clinical Result

	Manual procedure	Piezo-assisted
Cell survival after injection	30.47	54.74
Development to 2 cells	44.87	61.33
Development to morulae	28.20	34.67
Development to blastocysts	23.08	34.00

Selected references:

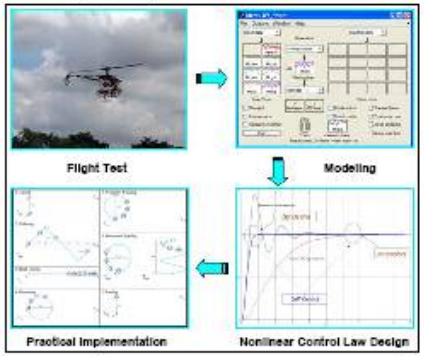
1. A.S. Putra, S. Huang, K.K. Tan, S.K. Panda, and T.H. Lee (2007), Design, modeling, and control of piezoelectric actuators for intracytoplasmic sperm injection, *IEEE Transactions on Control Systems Technology*.

B. Nonlinear Control of Unmanned Aerial Vehicle (UAV) Helicopters

Unmanned aerial vehicle (UAV) helicopter has aroused great interest worldwide because of its unique flight capacities. It has great potential in both military and civil applications. In academic circle, great success has been achieved in platform construction, software development, model identification and control algorithm implementation.

Multiple small-scale UAV helicopters have been constructed based on different scale hobby helicopters. Custom designed onboard hardware and software systems are implemented to realize the automatic flight.

The mathematic model which could accurately capture the flight dynamics is derived based on practical flight test data using system identification method. Based on the model, advanced flight control law such as Composite Nonlinear Feedback (CNF) control technique has been successfully designed and implemented to realize the full envelop automatic flight which includes automatic taking-off and landing. The research focuses are currently ground target tracking and multi-UAV formation control.



Selected references:

1. G. Cai, F. Lin, B. M. Chen and T. H. Lee (2008), Systematic design methodology and construction of UAV helicopters, *Mechatronics*.
2. G. Cai, B. M. Chen, K. Peng, M. Dong and T. H. Lee(2006), Comprehensive modeling and control of the yaw channel of a UAV helicopter, *IEEE Transaction on Industrial Electronics*.
3. K. Peng, M. Dong, B. M. Chen, G. Cai, K. Y. Lum and T. H. Lee (2006), Design and implementation of an Autonomous Flight Control Law for a UAV Helicopter, *Automatica*.

Onboard

- inertial measurement
- servo driving
- automatic control
- communication
- data logging

Helicopter

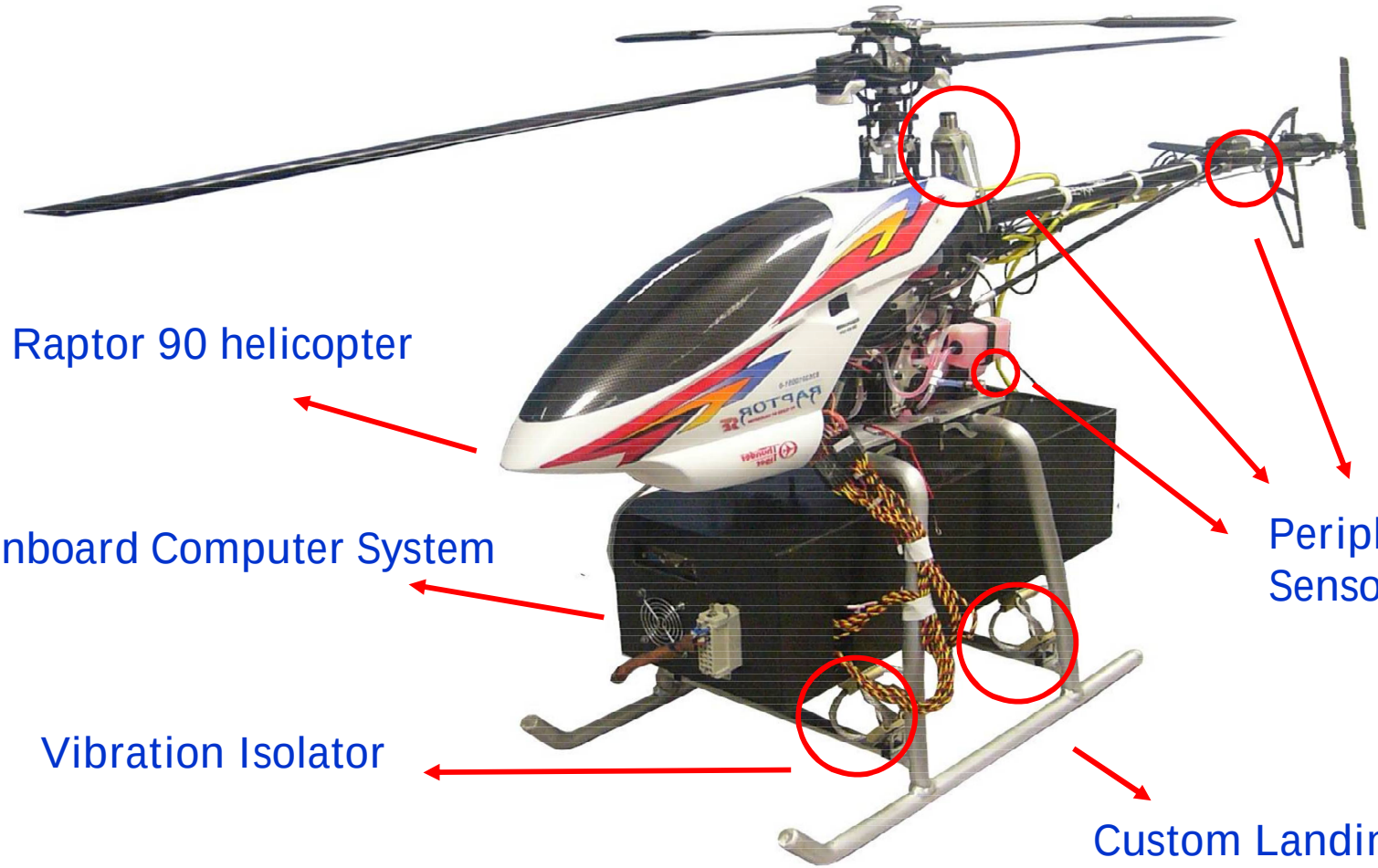
Communication

Ground Station

Ground Station

- data transferring (background)
- user interface (foreground)

UAV (Helicopter) control system



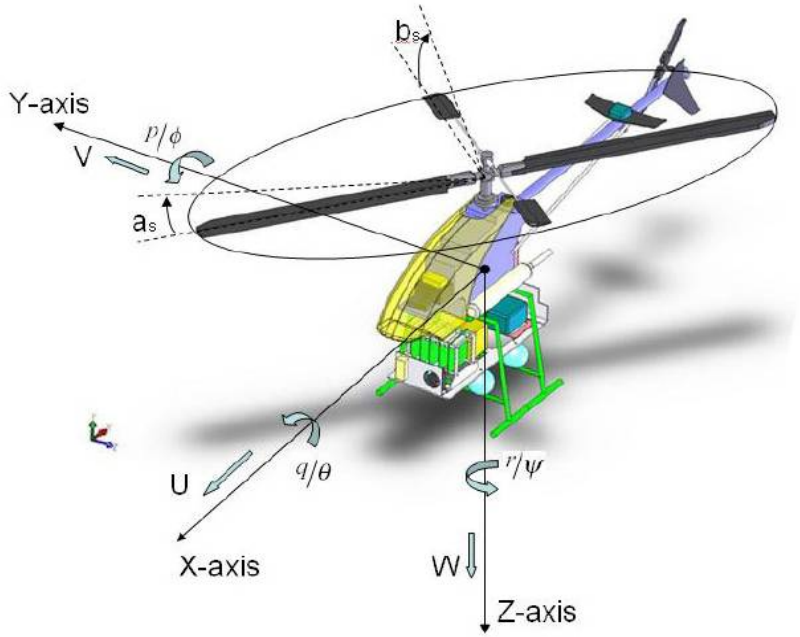
- Linear model for helicopter under specific flight condition

$$\dot{\mathbf{x}} = A\mathbf{x} + B\mathbf{u}$$

where

$$\mathbf{x} = (u, v, p, q, \phi, \theta, a_s, b_s, w, r, r_f, \zeta_a, \zeta_e, \zeta_u)$$

$$\mathbf{u} = (\delta_a, \delta_e, \delta_u, \delta_r)$$



National University of Singapore (NUS) - A global university centred in Asia - Microsoft Internet Explorer

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- MEDIA COVERAGE
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- PRESIDENT'S SPEECHES
- NUS PUBLICATIONS
- CALENDAR OF EVENTS

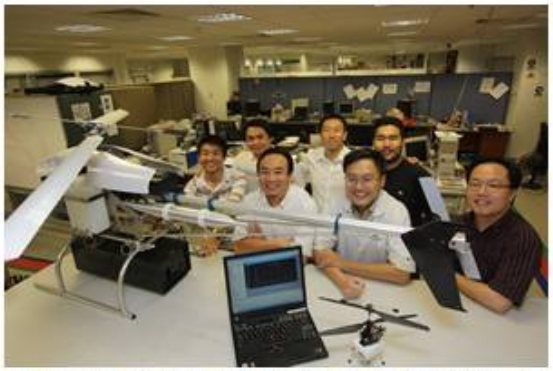
NUS Home > NewsHub > Whats New at NUS

NUS team wins 2009 Asian Control Conference Best Application Paper Award

04 Sep 2009

The Electrical and Computer Engineering Department has won the 2009 Asian Control Conference (ASCC) Best Application Paper Award for their work on the application of advanced modelling and control techniques on a real UAV platform. The team, comprising Prof Lee Tong Heng, Prof Ben M Chen and Mr Cai Guowei (Research Fellow), garnered the international win for their work on unmanned aerial vehicles (UAVs). Their control techniques have achieved top performance in the categories under examination, in accordance with the military standard set by the US Amy Aviation for military rotorcraft.

For the past several years, the team has been working on the design and implementation of a robust automatic flight control system. Elaborating on their research, Prof Chen said: "We have currently expanded our horizons to include cooperative control and coordination of multiple UAVs for indoor as well as urban navigation."



The UAV Research team at the Department of Electrical and Computer Engineering. Front row, from left: Mr Dong Xiangxu, Prof Ben M Chen, Prof Lee Tong Heng and Dr Lin Hai. Back row, from left: Mr Yun Ben, Mr Lin Feng and Mr Cai Guowei.

Done Internet

Autonomous camera drone lets you shoot your own action scenes

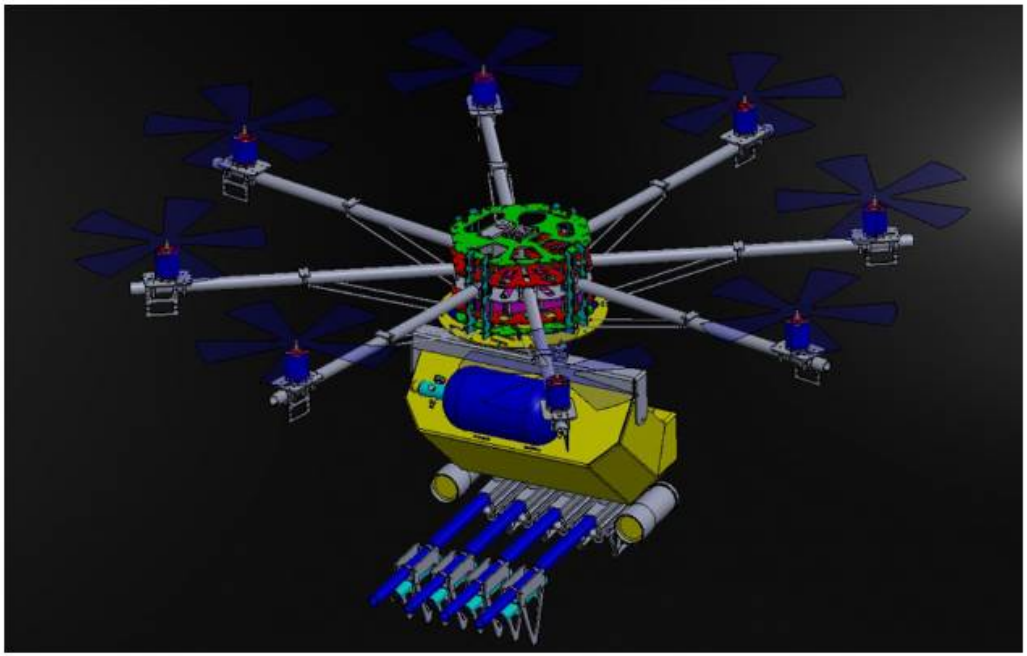
BY JON FINGAS @JONFINGAS • JUNE 15TH 2014, AT 11:00 PM ET

If you want to record a bike ride or some other adventure by yourself, you typically have to wear an action camera. Going that route is fine for a first-person view, but what if you want some more dramatic shots? That's where Hexoplus' crowdfunded Hexo+ camera drone comes into play. The robotic hexacopter captures aerial footage of your expeditions simply by detecting where you are (or rather, where your phone is) and following along -- you only have to set a preferred distance. It's fast (43MPH) and stabilized, too, so it should keep up even if you're racing across hilly terrain.

SOURCE: Hexoplus, Kickstarter

Crowd-control drones reveal the technology's dark side

BY DANIEL COOPER @DANIELWCOOPER • YESTERDAY AT 12:28 PM ET



The treatment of South African miners has been a troublesome issue ever since black laborers were forced into the mines in 1894. It's led to a series of bloody strikes and protests, starting in 1946 and continuing through apartheid right up until today. A new type of crowd suppression drone from a local defense contractor isn't going to help matters, especially given the fact that the country is in the grip of a 21-week miners' strike in which some protestors have already been killed. The Skunk, built by Desert Wolf, is designed to "control unruly crowds without endangering the lives of security staff," and is reportedly already being adopted by mine owners.

VIA: PrivacySOS
SOURCE: defenceWeb, Desert Wolf
MORE COVERAGE: L.A. Times, Global Research, Wikipedia, Reuters

National parks will soon ban most drone flights

BY JON FINGAS @JONFINGAS • JUN 20TH 2014 3:49PM

While we've already seen a few US national parks clamp down on drones in their airspace, it now looks like that no-fly rule is about to extend across the country. The National Park Service tells the *Associated Press* that it's about to order all 401 of its parks to ban unfettered use of drones on their grounds. Each park will have exceptions for high-altitude flyers, hobbyist clubs, researchers and rescuers, but you won't get to lug your personal camera drone around purely for the sake of remote sightseeing. If all goes according to plan, the Service will also have a preliminary national rule drafted within 18 months.

VIA: The Verge

SOURCE: Associated Press

CNN wants to prove that drones are safe for news reporting

BY STEVE DENT @STEVETDENT • JUN 24TH 2014 8:21AM

Stunning video footage like that from a recent tornado in Arkansas (see below) shows the potential for drones to radically change journalism. However, it's illegal to operate them in the US, especially near a disaster or accident scene -- which has prompted a new research project from CNN and the Georgia Institute of Technology. The aim is to figure out which type of equipment, personnel and safety measures would be needed to safely operate news-gathering drones in US airspace. While such UAVs would no doubt give media outlets like CNN improved coverage, they'd often end up in close proximity to crowds, emergency personnel and even rescue aircraft. That means US regulators might be reluctant to approve them for reporting -- even though they've already authorized lower-risk activities like pipeline inspection. CNN's group hopes to show the FAA that it can be made safe for journalism, likely so that it won't be frozen out when new drone regulations are finally announced.

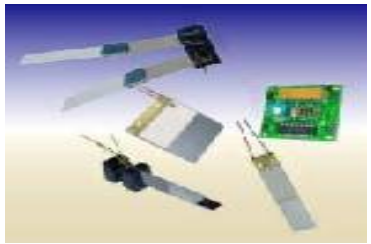
[Image credit: Brian Emfinger via YouTube]

READ THE FULL STORY | 30 COMMENTS SHARE

SOURCE: CNN

Development of a Precision Control System (5 micron) for Intracytoplasmic Sperm Injection

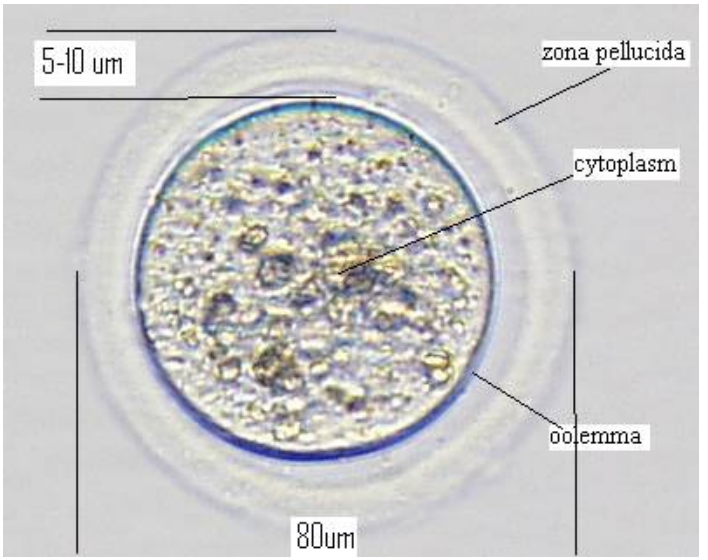
T.H.Lee, with co-workers (K.K.Tan, S.C.Ng, & researchers)



National University of Singapore

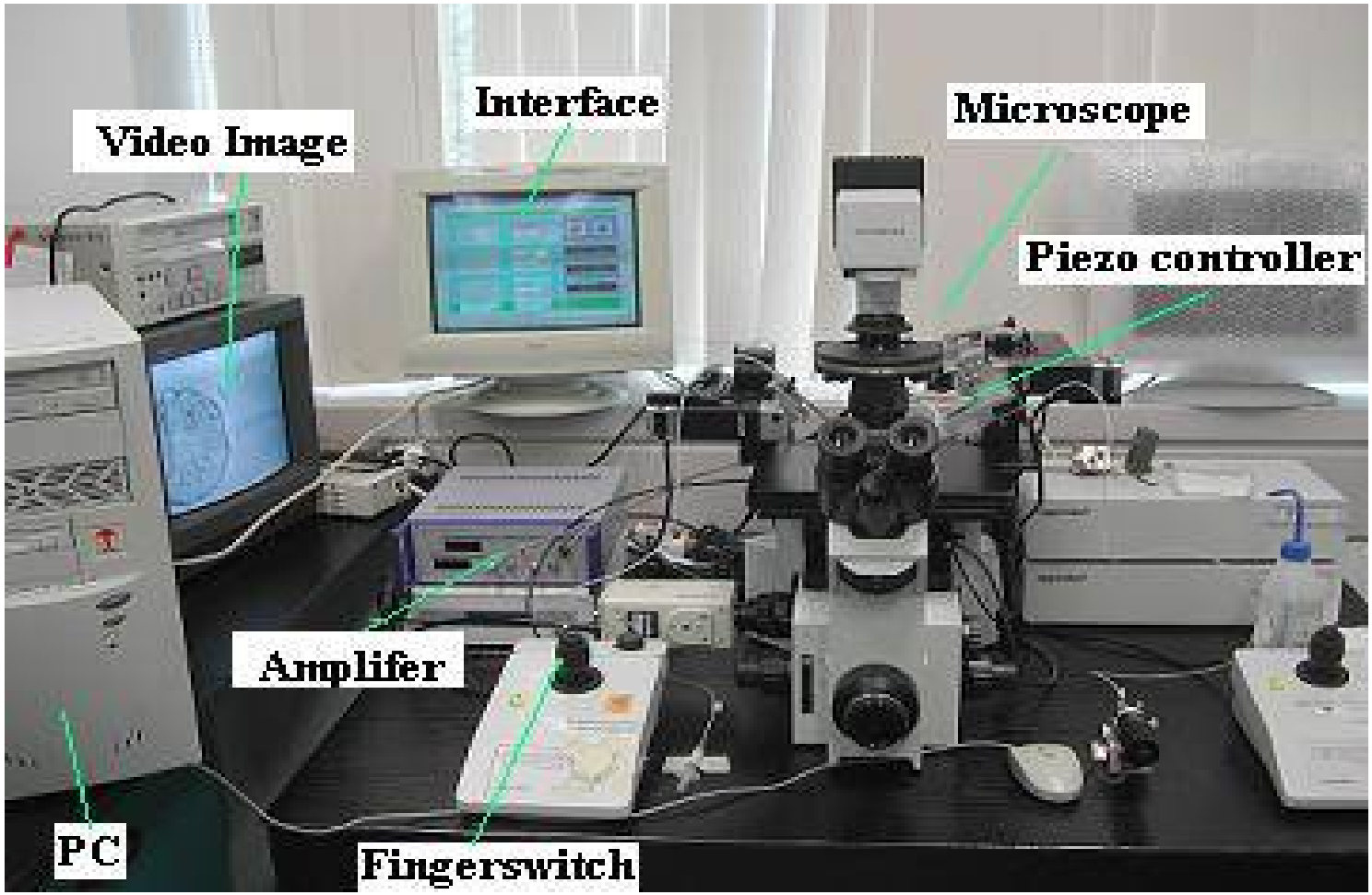
Organisation of the Oocyte

Mice Sperm



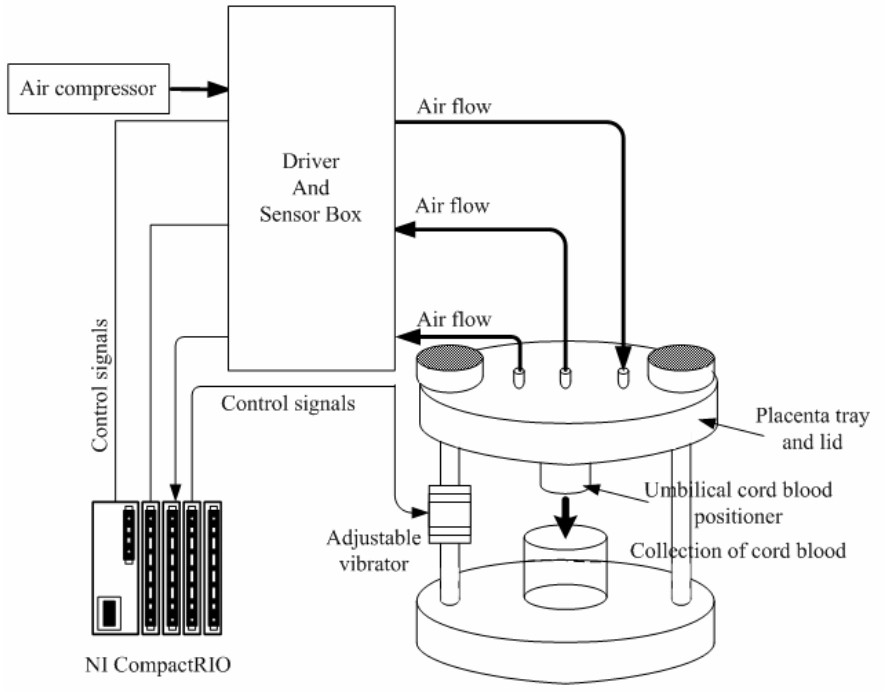
Mice Oocyte

Integrated System



Projects Involving the Life Sciences

Umbilical Cord Blood Collection Using Automated Machine



IEEE

IEEE ICMA 2009

The 2009 IEEE International Conference on
Mechatronics and Automation

Robotics and Automation Society

Best Paper Award in Automation

In the 2009 IEEE International Conference on Mechatronics and Automation (IEEE ICMA 2009) to

**K.K. Tan, K.Z. Tang, S. Huang, A.S. Putra, T.H. Lee, S.C. Ng,
Jerry K.Y. Chan, L.G. Tan and Mark S.K. Chong**

For the paper entitled

Automated Haematopoietic Stem Cells Harvesting Machine

August 9~12, 2009

Toshio Fukuda
General Chair of ICMA2009
Nagoya University, Japan

Shuxiang Guo
General Chair of ICMA2009
Kagawa University, Japan

Yong Yu
Program Chair of ICMA2009
Kagoshima University, Japan

"But lest we forget…beware, the sinking (boasted of as being "unsinkable") of the Titantic…etc…"

… engineers [need to] realize how their technical work has far reaching impacts on society. The work of engineers can affect public health and safety and can influence business practices and even politics.

***Fleddermann* 4th Ed Chapter 1, page 2**

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EG 2401(a) Engineering Professionalism

Lecture 1

Sem I, AY 2021-22

T.H.Lee, B.A. (Hons I) Cambridge; M.Engrg NUS; Ph.D. Yale
NUS Faculty of Engineering
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Aug/Sep 2021

TOPIC 1 – Introduction (Issues)

- **THL1.1 - Some Background & Preliminaries**
- **THL1.2 - Why Study Engineering Ethics?**
- **THL1.3 - Origins of Ethical Thought – Some Pertinent Points**
- **THL1.4 - Ethics Problems -- Like Engineering Design Problems? How so?**
- **THL1.5 - Illustrative Cases**
- **THL1.6 - Summary (I)**

Reference Reading: *Fleddermann* 4th Ed Chapter 1

THL1.1 - Some Background & Preliminaries - LECTURES (24 Hours)

NUS National University of Singapore

➢ 1. Introduction (Issues)	- 2 Hrs (T.H.Lee)
➢ 2. Ethical Theories	- 2 Hrs (T.H.Lee)
➢ 3. Ethical Problem Solving Techniques	- 2 Hrs (T.H.Lee)
➢ 4. Engineer at the Workplace	- 2 Hrs (Kevin Kuang)
➢ 5. Academic and Research Ethics	- 2 Hrs (Kevin Kuang)
➢ 6. Role of Professional Societies	- 2 Hrs (Kevin Kuang)
➢ 7. Commitment to Safety	- 2 Hrs (K.G.Neoh)
➢ 8. International Engineering Professionalism	- 2 Hrs (K.G.Neoh)
➢ 9. Engineers and the Environment	- 2 Hrs (K.G.Neoh)
➢ 10. Intellectual Property Rights (LAW)	- 6 Hrs (Oliver Quek)

EG2401 2021-22 Semester 1 Schedule							
Week		Tutorials		Lectures[1]			
No	Starting	No.	Set by	No.	By	Date	
						Group 1	Group 2
1	9-Aug-21	**No tutorials**		**1**	LTH	10-Aug-21	12-Aug-21
2	16-Aug-21	**No tutorials**		**2**	LTH	17-Aug-21	19-Aug-21
3	23-Aug-21	**No tutorials**		**3**	LTH	24-Aug-21	26-Aug-21
4	30-Aug-21	**0**[2]	-	**4**	KK	31-Aug-21	2-Sep-21
5	6-Sep-21	**1**	LTH	**5**	KK	7-Sep-21	9-Sep-21
6	13-Sep-21	**2**	LTH	**6**	KK	14-Sep-21	16-Sep-21
Break	20-Sep-21	**No tutorials or lectures during the break**					
7	27-Sept-21	**E**[3]	-	**7**	NKG	28-Sept-21	30-Sept-21
8	4-Oct-21	**3**	KK	**8**	NKG	5-Oct-21	7-Oct-21
9	11-Oct-21	**No tutorials**		**9**	NKG	12-Oct-21	14-Oct-21
10	18-Oct-21	**4**	NKG	**10**	OQ	19-Oct-21	21-Oct-21
11	25-Oct-21	**No tutorials**[4]		**11**	OQ	26-Oct-21	28-Oct-21
12	1-Nov-21	**GP Presentation**[4]	ALL	**No lectures**			
13	8-Nov-21	**GP Presentation**[4]	ALL	**12**	OQ	9-Nov-21	11-Nov-21

Legend: LTH: Prof. Lee Tong Heng; KK: Prof. Kevin Kuang; NKG: Prof. Neoh Koon Gee; OQ: Mr. Oliver Quek

[1] The Lecture classes (on-line) are on Tuesdays (Gp 1) from 2 pm to 4 pm and Thursdays (Gp 2) from 6 pm to 8 pm.
[2] Tutorial 0 is compulsory and will be used for discussion group division / project allocation and other administrative matters
[3] Tutorial E class (E='Extra') will be used to cover questions from Tutorials 1 & 2 which could not be done earlier or for a discussion on the projects. Please check with your tutor to find out what will be covered in this tutorial class
[4] The GP (group project) presentations will be held during Weeks 12 and 13 for all Tutorial Groups except the Thur Groups since Nov 4 (Thur) is Deepavali. For Thur Groups, GP Presentations will on Weeks 11 and 13 unless the tutors make alternative arrangements

Public Holidays:
Mon Aug 9 National Day
Thur Nov 4 Deepavali

Assessment

EG2401
Final Examination - 50 %
Continual Assessment - 50 %

CA Details:
Tutorial Participation - 20 %
Group Project - 30 %
The group project will be assessed based on overall project execution, project report and project presentation.

****

EG2401a
Continual Assessment - 100 %

CA Details:
Tutorial Participation - 40 %
Group Project - 60 %
The group project will be assessed based on overall project execution, project report and project presentation.

Text & Readings

Textbooks:

1. C.E. Harris, Jr., M. S. Pritchard & M. J. Rabins, "Engineering Ethics - Concepts and Cases", Thomson Wadsworth, 4th ed.

2. C. B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, 3rd or 4th ed. (Adapted for EG 2401)

Supplementary Readings:

M. W. Martin & E. Schinzinger, "Ethics in Engineering", McGraw Hill, 4th ed.

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What this module is not about…

- ***This module will not attempt to re-invent or contest or re-consider the origins of ethical thought. It is not a module to "discourse" the fundamental tenets of ethics.***

- ***Thus note: "In most situations, the correct response to an ethical problem is very obvious." [Fleddermann 4th Ed Chapter 1, page 3] I.e. The module accepts whatever "ethical persuasion" each individual embraces; noting that all major ethical persuasions do not disagree essentially on what is ethical, and what is not. (See also later.)***

What this module is not about…

- *The statements above are not without proper intellectual basis. Even in what we "regard" to be the "hard sciences" --- in reality, fundamental suppositions have already been made (at some onset) to allow the pursuit of the said field to proceed without being impeded & dragged into the abyss of possibly unwieldy philosophical "paradoxes". Recall what you may have met before on this, of (say) the so-called scientific concepts of "fundamental undefinables" or the "deepness" of "infinity" etc. Or just come over to me and talk later… ☺☺*

- *This, then, is the standpoint that we will take in developing this module. I.e. We will accept/embrace the major origins of ethical thought; and then (in the module) learn to skillfully deploy these to address "Engineering Professionalism & Ethics".*

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Reference Reading: *Fleddermann* 4th Ed Chapter 1

THL1.2 - Why Study Engineering Ethics?

- ***A primary goal of the module is to sensitize you to important ethical issues before you have to confront them.***

- ***<u>Moral autonomy</u>: the ability to think critically and independently about moral issues and to apply this moral thinking to situations that arise in the course of professional engineering practice. Stated another way, a clear goal of this module is to foster the moral autonomy of future engineers. I.e. "mould" each engineering graduate as a "<u>moral autonomous agent</u>".***

THL1.2 - Why Study Engineering Ethics?

- ***In most situations, the correct response to an ethical problem is very obvious. Then, just do the obvious.***

- ***However, many times, the ethical problems encountered in engineering practice are very complex and involve conflicting ethical principles.***

THL1.2 - Why Study Engineering Ethics?

- ***<u>A key question</u>: Where does an engineering team strike the balance between safety and affordability and, simultaneously, between the ability of the company to sell (its product) and make a profit?***

- ***<u>Engineering is managing the unknown</u>: As an engineer, you can never be absolutely certain that your design will never harm anyone or cause detrimental changes to society.***

THL1.2 - Why Study Engineering Ethics?

- ***<u>Engineering is managing the unknown</u>: You must test your design as thoroughly as time and resources permit to ensure that it operates safely and as planned.***

- ***<u>Engineering is managing the unknown</u>: Also, you must use your creativity to attempt to forsee the possible consequences of your work.***

THL1.2 - Why Study Engineering Ethics?

- ***<u>Personal vs Professional Ethics</u>: Personal ethics deals with how we treat others in our day-to-day lives. [Indeed] many of these principles are likewise applicable to ethical situations that occur in engineering and business.***

- ***<u>Personal vs Professional Ethics</u>: However, professional ethics often [additionally] involves choices on an organizational level rather than [merely] a personal level.***

THL1.2 - Why Study Engineering Ethics?

- ***<u>Personal vs Professional Ethics</u>: Many of the problems take on a different complexity [we will see in the Case Study in next two Lectures!!] because they involve relationships between two corporations, or between a corporation and the government etc.***

- ***<u>Personal vs Professional Ethics</u>: Frequently, these types of relationships pose problems [of a different nature] that are not encountered in personal ethics.***

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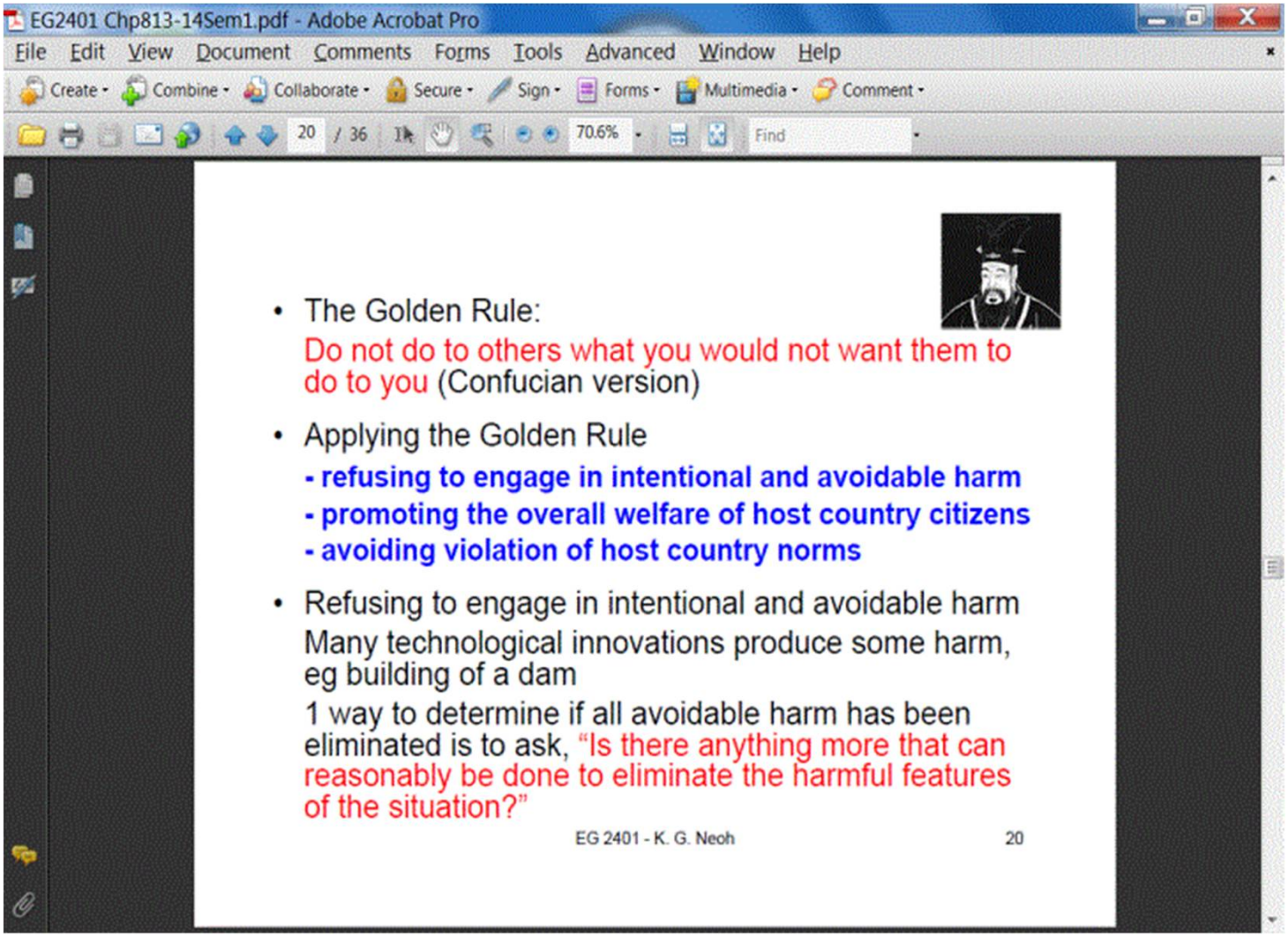
Reference Reading: *Fleddermann* 4th Ed Chapter 1

THL1.3 - Origins of Ethical Thought – Some Pertinent Points

- ***Acknowledgement -- The Western ethical thought (used in the Fleddermann book) has origins in the philosophy of the ancient Greeks and their predecessors.***

- ***"Interestingly, non-Western cultures have independently developed similar ethical principles." [*Fleddermann* 4th Ed Chapter 1, page 4]***

THL1.3 - Origins of Ethical Thought – Some Pertinent Points



An important "note" – Ethics & the Law…

- ***The practice of engineering is governed by many laws on the international, federal, state & local levels. Many of these are based on ethical principles, although many are purely of a practical, rather than a philosophical nature.***

- ***In the law, within each jurisdiction, there (unfortunately, yet often is the case) is … a distinction between what is legal and what is ethical.***

An important "note" – Ethics & the Law…

- ***Many things that are legal could [actually] be considered unethical. [Fleddermann 4th Ed Chapter 1, page 4] For example, designing a process that releases a known toxic, but [as yet] unregulated, substance into the environment is probably unethical, although it is [would be] legal.***

- ***Conversely, just because something is illegal does not automatically mean that it is unethical. Example --- cases of the law not having yet caught up with the most recent scientific findings, and regulating based on outdated formulations. (Recall also the earlier "UAV drone-usage for disaster reporting" article from Engadget ©.)***

An important "note" – Ethics & the Law…

- ***As an engineer, you are always minimally safe if you follow the requirements of the applicable laws. [Fleddermann 4th Ed Chapter 1, page 5]***

- ***But in "engineering ethics" [and in this module], we seek to go beyond the dictates of the law. Our interest is also in areas where ethical principles conflict and there is possibly no legal guidance for how to resolve the conflict. [You will see these situations shortly in Lectures 2 & 3.]***

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Reference Reading: *Fleddermann* 4th Ed Chapter 1

THL1.4 - Ethics Problems -- Like Engineering Design Problems? How so?

- ***The types of problems that we will encounter in studying engineering ethics are very similar [in their nature] to the design problems that engineers work on everyday. [This part is rather obvious!! I skipped this part of the book. Thus, please also read Fleddermann 4th Ed Chapter 1, page 5] As in design, there will not be a single correct answer.***

- ***Engineering ethics problems will have multiple correct solutions, with some solutions being better than others.***

Key results in adaptive and predictive control

A. Implicit Function Based Control

In nonlinear control literature, it is not easy to control a non-affine systems, because the output depends nonlinearly on the input.

Control design for

$$affine\ systems: y(k+1) = f(y(k)) + g(y(k))u(k)$$
$$--feedback\ linearization$$
$$nonaffine\ systems: y(k+1) = f(y(k), u(k))$$
$$--how\ to\ find\ an\ input\ u(k)??$$

Implicit function theorem method has been first developed in (Goh and Lee, 94), to identify the existence of an ideal control for adaptive control design.

Discrete Nussbaum Gain

Control direction: $the\ sign\ of\ \partial f(x,u)/\partial u$, "+" or "−"

$--$ *the direction the control operates*

The control direction is normally required to be known for adaptive and neural network control.

In the absence of control direction, how to design adaptive control?

To tackle this problem, the Discrete time Nussbaum Gain, $N(x(k))$, has been first developed in (Lee, 86) for discrete-time adaptive control.

Discrete Nussbaum Gain N(x(k)):

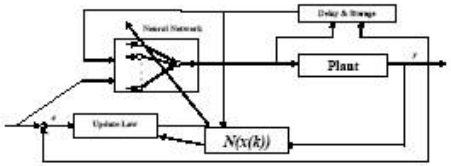
$$N(x(k)) = \sup\{x(k)\} \varepsilon(x(k)),\ S_N(x(k)) = \sum_{k'=0}^{k} N(x(k'))\Delta x(k')$$

It adapts by searching alternately with:

$$\sup \frac{1}{x(k)} S_N(x(k)) = +\infty, \inf \frac{1}{x(k)} S_N(x(k)) = -\infty$$

Controlling non-affine system with unknown control direction

Develop Implicit Function and Discrete Nussbaum Gain together in neural network (NN) control, as shown below:



To deal with external disturbance, a deadzone can be used in the update law with a threshold value λ. Using the proposed adaptive NN control, the main results are summarized as follows:

Theorem (Yang, Ge, ., Lee, 2008):

All closed-loop signals are guaranteed to be semi-globally uniformly ultimately bounded, the discrete Nussbaum gain $N(x(k))$ will converge to a constant, and the tracking error $e(k) = y(k) - y_d(k)$ satisfies $\lim_{k\to\infty} |e(k)| \le \lambda$ with $\lambda = \lim_{k\to\infty} |\varepsilon(x(k))|$.

B. Delay Compensation for Input-delay Systems via Predictive Control Design

Input delay phenomena arise from practical control problems in many processes such as chemical reaction and remote communication. A system with input delay implies that the control input will not affect the system once after its generation.

Numerous techniques are available in controller design for linear systems; However, for nonlinear systems with constant input delay, simple and feasible methods are not commonly seen. A predictive control scheme is proposed here for both linear and nonlinear systems. **The central idea is that the control signal is constructed based on the prediction of the state in the future rather than on the current state. Its performance depends on the prediction accuracy.**

Consider a general class of nonlinear system with constant input delay L

$$\dot{x}(t) = f(x(t), u(t-L)).$$

Step 1: Set $u^*(t) = u(t-L).$

Step 2: Design controller for the delay free system

$$u^*(t) = g(x(t)) = u(t-L).$$

Step 3: Use the predicted state to construct the control signal for the input-delay system.

$$u(t) = g(\hat{x}(t+L))$$

- Analytical solution to the system available → Perfect prediction
- Analytical solution to the system unavailable → Numerical scheme with high accuracy

Theorem (Xiang, Cao, Wang & Lee, 2008):

Consider a nonlinear input-delay system

$$\dot{x}(t) = f(x(t), u(t-L)),\ y(t) = h(x(t)),\ t \ge t_0$$

Using predictive controller produced by the above 3 steps, bounded tracking error between the system output and reference signal can be achieved under the following 2 assumptions:

Assumption 1: The prediction error is bounded

$$\|x(t) - \hat{x}(t)\| \le \varepsilon, \quad \forall t \ge t_0$$

Assumption 2: Given any two states $x(t)$ and $\hat{x}(t)$, there exists a constant $\gamma > 0$ such that

$$\|f(x(t), u) - f(\hat{x}(t), u)\| \le \gamma \|x(t) - \hat{x}(t)\|$$

Furthermore, perfect tracking can be achieved if the prediction error is zero.

Selected references:

1. Q.G. Wang, T.H. Lee and K.K. Tan (1998), Finite spectrum assignment for time-delay systems, Springer, London.
2. C. Xiang, L.L. Cao, Q.G Wang and T.H. Lee, A general framework for delay compensation for input-delay systems via predictive control design. (2008; under review)

Recent developments in Advanced Control Systems

A. Development of Piezoelectric Actuator for Intra-Cytoplasmic Sperm Injection (ICSI) Application

What and why ICSI

- ICSI is an artificial insemination method where fertilization is achieved by injection of one sperm directly into the cytoplasm of an oocyte (egg cell).
- ICSI addresses the issue of male infertility.
- It can help increasing birth rate in Singapore.

ICSI Procedure

A. Captured of sperm by the injection pipette
B. Penetration of zona pellucida
C. Penetration of oolemma
D. Positioning of pipette inside the cytoplasm
E. Expulsion of sperm to the cytoplasm
F. Withdrawal of injection pipette from the oocyte

Why Piezo-Assisted ICSI

- Imprecise penetration by manual operation
- Inconsistent stress on the oocyte by operator
- Vibration and deformation of oocyte with manual injection

Experimental Setup

Clinical Result

	Manual procedure	Piezo-assisted
Cell survival after injection	30.47	54.74
Development to 2 cells	44.87	61.33
Development to morulae	28.20	34.67
Development to blastocysts	23.08	34.00

Selected references:

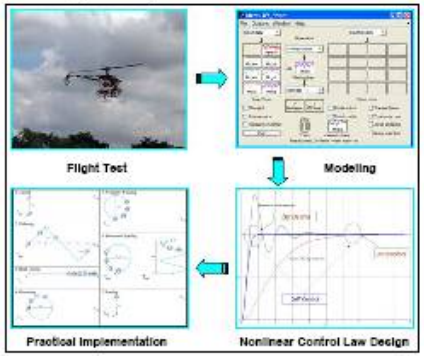
1. A.S. Putra, S. Huang, K.K. Tan, S.K. Panda, and T.H. Lee (2007), Design, modeling, and control of piezoelectric actuators for intracytoplasmic sperm injection, *IEEE Transactions on Control Systems Technology*.

B. Nonlinear Control of Unmanned Aerial Vehicle (UAV) Helicopters

Unmanned aerial vehicle (UAV) helicopter has aroused great interest worldwide because of its unique flight capacities. It has great potential in both military and civil applications. In academic circle, great success has been achieved in platform construction, software development, model identification and control algorithm implementation.

Multiple small-scale UAV helicopters have been constructed based on different scale hobby helicopters. Custom designed onboard hardware and software systems are implemented to realize the automatic flight.

The mathematic model which could accurately capture the flight dynamics is derived based on practical flight test data using system identification method. Based on the model, advanced flight control law such as Composite Nonlinear Feedback (CNF) control technique has been successfully designed and implemented to realize the full envelop automatic flight which includes automatic taking-off and landing. The research focuses are currently ground target tracking and multi-UAV formation control.



Selected references:

1. G. Cai, F. Lin, B. M. Chen and T. H. Lee (2008), Systematic design methodology and construction of UAV helicopters, *Mechatronics*.
2. G. Cai, B. M. Chen, K. Peng, M. Dong and T. H. Lee(2006), Comprehensive modeling and control of the yaw channel of a UAV helicopter, *IEEE Transaction on Industrial Electronics*.
3. K. Peng, M. Dong, B. M. Chen, G. Cai, K. Y. Lum and T. H. Lee (2006), Design and implementation of an Autonomous Flight Control Law for a UAV Helicopter, *Automatica*.

Onboard

- inertial measurement
- servo driving
- automatic control
- communication
- data logging

Helicopter

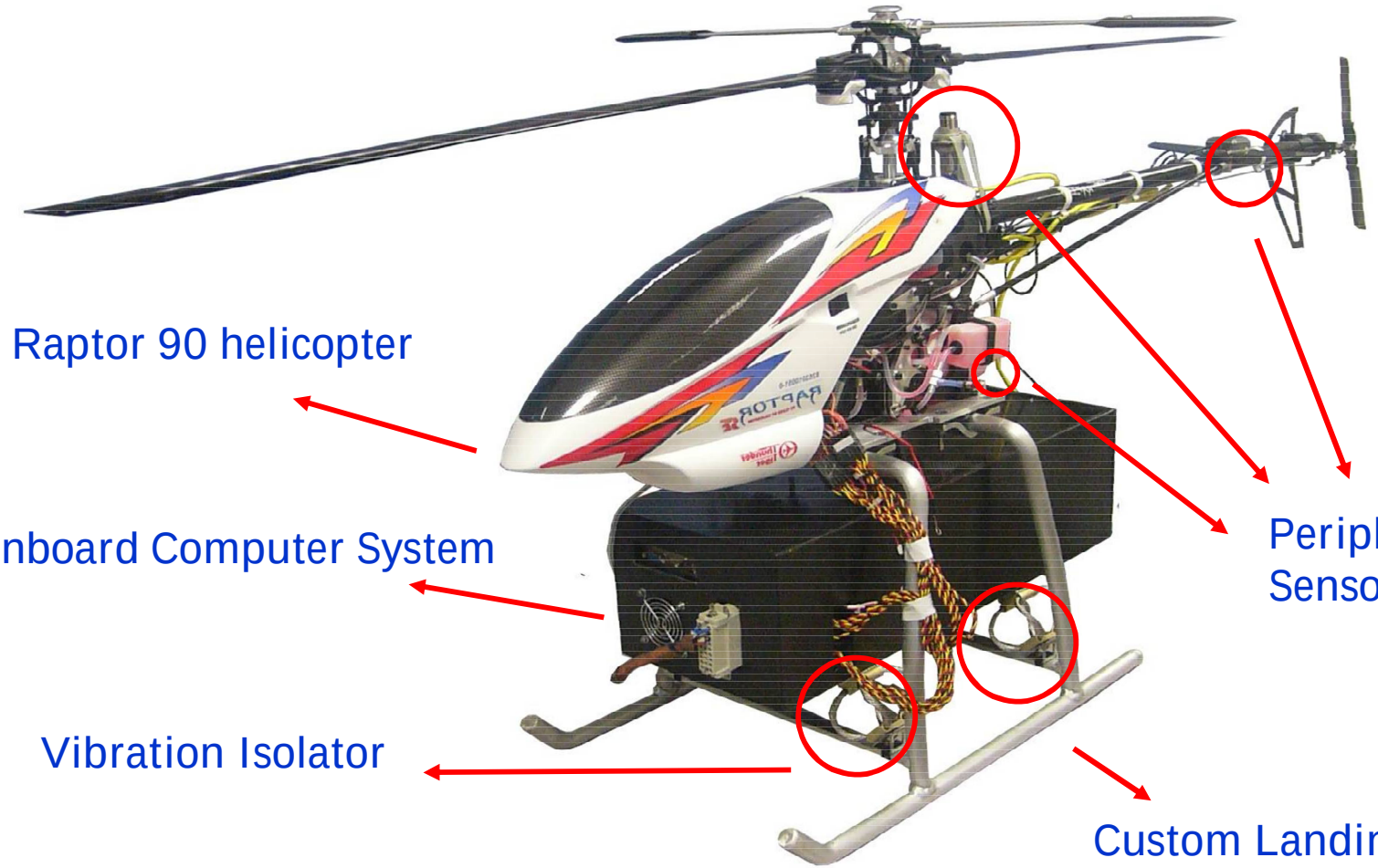
Communication

Ground Station

Ground Station

- data transferring (background)
- user interface (foreground)

UAV (Helicopter) control system



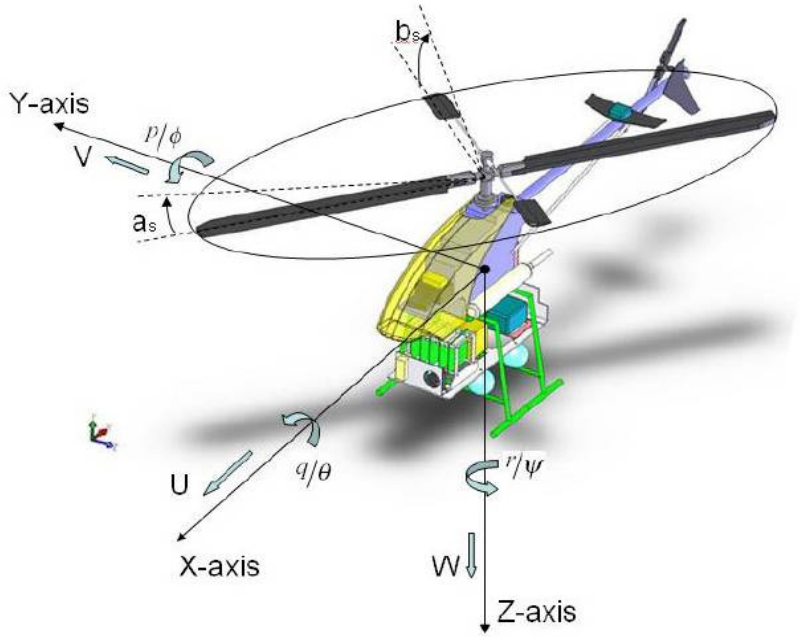
- Linear model for helicopter under specific flight condition

$$\dot{\mathbf{x}} = A\mathbf{x} + B\mathbf{u}$$

where

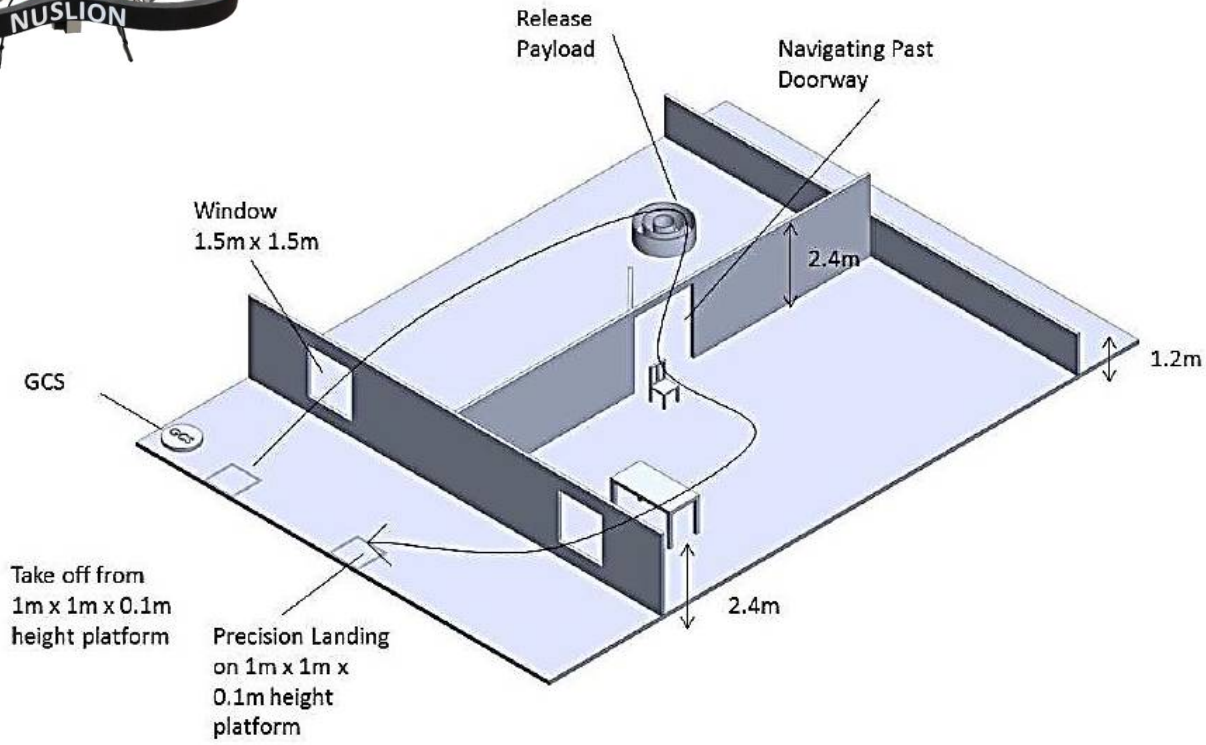
$$\mathbf{x} = (u, v, p, q, \phi, \theta, a_s, b_s, w, r, r_f, \zeta_a, \zeta_e, \zeta_u)$$

$$\mathbf{u} = (\delta_a, \delta_e, \delta_u, \delta_r)$$



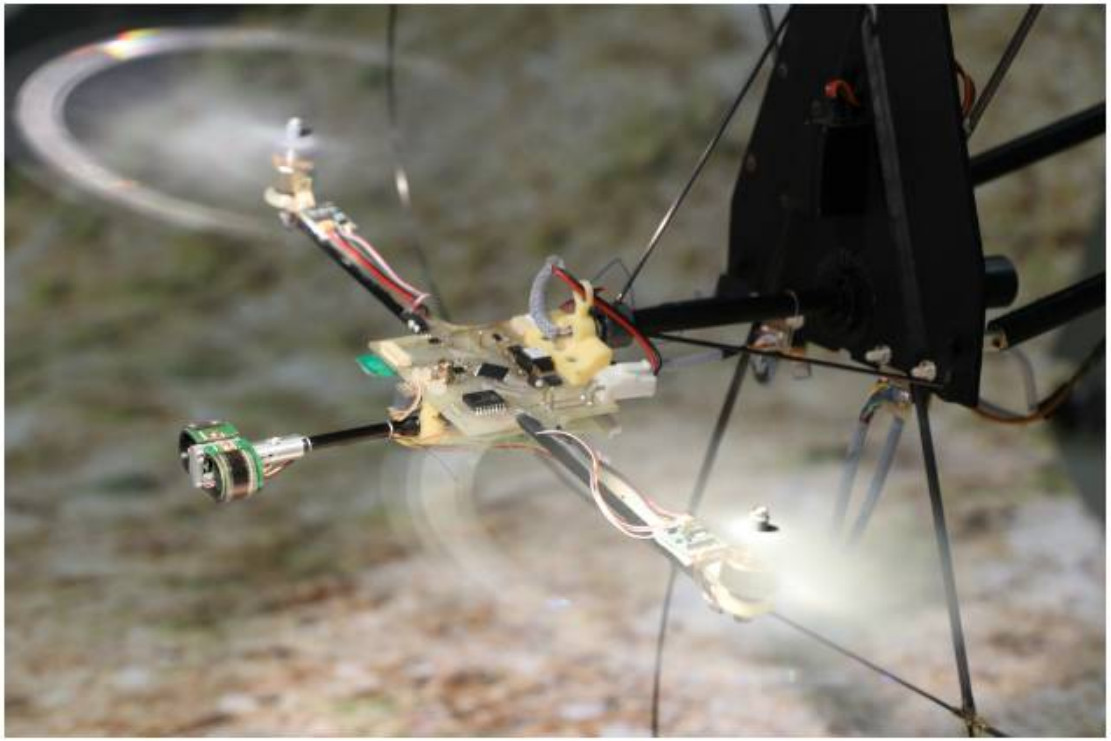
A different design…

- Auto take off
- Enter window
- Payload drop
- Navigate door way
- Obstacle avoidance
- Exit window
- Auto landing



'BeeRotor' drone uses an insect-style eye to navigate tight spaces

by Nick Summers | @nisummers | March 16th 2015 at 11:33 am



Accelerometers have become integral components for many of our favorite gadgets. By measuring acceleration forces, such as gravity or someone's arm waving clumsily back and forth, these sensors can accurately identify a device's angle in relation to the Earth. It's how your smartphone knows when to automatically switch between portrait and landscape orientation. Now, scientists are researching how drones can be built to fly autonomously without the use of accelerometers. It's led to the creation of "BeeRotor," which, as the name implies, takes inspiration from the visual cues and analysis used by winged insects.

The Pentagon wants unhackable drone helicopters by 2018

by Andrew Tarantola | @terrortola | March 16th 2015 at 4:40 pm

Losing a UAV or two to enemy forces has become an unavoidable cost of modern warfare. But there's still a big difference between having a Scan Eagle turn up missing and, say, the Pentagon's autonomous MH-6 Little Bird -- namely because only one of those is armed to the talons with chainguns, Hydra rockets and Hellfire missiles. That's why DARPA engineers are working to harden the Little Bird's electronic defenses against external hacking and keep the pint-sized killing machine from going AWOL.

Biological fungus drone can melt into a puddle of goop

Everything except the rotors and battery, anyway

By Rich McCormick on November 13, 2014 03:14 am *Email*

Share on Facebook Tweet (226) Share Sha

A biodegradable drone made mainly of mushroom mat
The quadrotor drone was built at NASA's Ames research center, and is the first step to producing an unmanned aerial vehicle that operators can use to explore remote locations without potentially contaminating them with old electronics, or to spy in sensitive areas before allowing the device to melt away into the ground.

The drone's chassis was made of mycelium, a fungal material that can be grown into specific shapes, from packaging to surfboard cores. That mycelium was given a covering of cellulose "leather" sheets grown by bacteria, before being coated in the same proteins paper wasps use to coat their nests, cloned from the insects saliva. Even its circuits were printed with silver nanoparticle ink to aid biodegradation.

THE DRONE'S BODY WAS MADE OF FUNGAL MATERIAL MYCELIUM

The drone's chassis was made of mycelium, a fungal material that can be grown into specific shapes, from packaging to surfboard cores. That mycelium was given a covering of cellulose "leather" sheets grown by bacteria, before being coated in the same proteins paper wasps use to coat their nests, cloned from the insects saliva. Even its circuits were printed with silver nanoparticle ink to aid biodegradation.

THE DRONE'S BODY WAS MADE OF FUNGAL MATERIAL MYCELIUM

© TheVerge

Amazon doesn't want states regulating courier drones

by Jon Fingas | @jonfingas | June 16th 2015 at 9:56pm

© Engadget

If you thought Amazon was already fighting tooth-and-nail for permission to fly delivery drones in the US, you haven't seen anything yet. The internet shopping giant has warned a House oversight committee that states and cities "must not be allowed" to regulate unmanned aircraft that get the Federal Aviation Administration's approval. There should be only one set of rules for airspace, purpose and qualifications, Amazon says. It's not hard to see why the company would be nervous -- it could be very tricky to run a nationwide courier drone service if some states have strict requirements or ban these services entirely.

THL1.4 - Ethics Problems -- Like Engineering Design Problems? How so?

- ***The types of problems that we will encounter in studying engineering ethics are very similar [in their nature] to the design problems that engineers work on everyday. [This part is rather obvious!! I skipped this part of the book. Thus, please read Fleddermann 4th Ed Chapter 1, page 5] As in design, there will not be a single correct answer.***

- ***Engineering ethics problems will have multiple correct solutions, with some solutions being better than others. [Again, you will shortly see these in Lectures 2& 3.]***

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TOPIC 1 – Introduction (Issues)

- **THL1.1 - Some Background & Preliminaries**
- **THL1.2 - Why Study Engineering Ethics?**
- **THL1.3 - Origins of Ethical Thought – Some Pertinent Points**
- **THL1.4 - Ethics Problems -- Like Engineering Design Problems? How so?**
- **THL1.5 - Cases (Homework Reading!!!)**
- **THL1.6 - Summary (I)**

Reference Reading: *Fleddermann* 4th Ed Chapter 1

Example I: Waste Isolation Pilot Plant (WIPP), Carlsbad, NM U.S.A. *[read also Fleddermann Chapter 3]*

WIPP is designed to be a permanent repository for nuclear waste generated in the United States. It consists of a system of tunnels bored into underground salt formations. These salt beds are considered by geologists to be extremely stable, especially to incursion of water which could lead to seepage of the nuclear wastes into ground-water. However, there are many who oppose this facility, principally on the grounds that transportation of the wastes across highways has the potential for accidents that might cause health problems for people living near these routes.

Read also the more detailed article, available as a free download from Wikipedia©, which is also in "Assigned Readings" IVLE Folder...

Example I: Waste Isolation Pilot Plant (WIPP), Carlsbad, NM U.S.A. *[read also Fleddermann Chapter 3]*

Waste Isolation Pilot Plant	
WIPP	
 WIPP, a geological repository for radioactive waste	
Country	United States
State	New Mexico
County	Eddy County
Nearest city	Carlsbad

© Wikipedia

Shipment of casks arriving at the WIPP

Read also the more detailed article, available as a free download from Wikipedia©, which is also in "Assigned Readings" IVLE Folder...

Read also the more detailed related articles, available as a free download from Wikipedia©, which is also in "Assigned Readings" IVLE Folder...

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Example II: The Goodrich A7-D Brake Case *[read also Fleddermann pp 114-116]*

… In June of 1967, Goodrich was awarded the contract to supply the brakes for the A7-D by LTV, the prime contractor for the airplane. The qualifying of this new design was on a very tight schedule imposed by the Air Force. The new brake had to be ready for flight testing by June of 1968, leaving only one year to test and qualify the design. To qualify the design for the flight test, Goodrich had to demonstrate that it performed well in a series of tests specified by the Air Force.

… In the course of writing the report on the A7-D brake tests, Vandivier became aware that some of the test results had been rigged to meet the Air Force's specifications. Vandivier raised his concerns about the report he was writing, feeling that he couldn't write a report based on falsified data. His attempts to write an accurate report were not allowed by management, and Goodrich submitted a report using the jury-rigged data. Based on this report, the brake was qualified for flight testing.

Read also the more detailed related articles, available as a free download from Wikipedia©, which is also in "Assigned Readings" IVLE Folder...

Example II: The Goodrich A7-D Brake Case *[read also Fleddermann pp 114-116]*

A-7 Corsair II	
	
U.S. Navy A-7E from Attack Squadron 46 (VA-46)	
Role	Attack aircraft
Manufacturer	Ling-Temco-Vought
First flight	26 September 1965
Introduction	February 1967

Close-up of a disc brake on a car

A railroad bogie and disc brakes

© Wikipedia

Example: The Goodrich A7-D Brake Case *[read also Fleddermann pp 114-116; full text here]*

This case is one that is very often used as an example in engineering ethics texts, especially to study whistle-blowing. In studying this case, it is important to keep in mind that much of the information presented here is derived from the writing of the whistle-blower. An individual who is deeply embroiled in a controversial situation such as this one will have different insights and viewpoints on the situation than will management or other workers. Little is publicly known about what Goodrich management thought about this case.

In the 1960s, the B.F.Goodrich Corporation was a major defense contractor. One of their main defense-related industries was the production of brakes and wheels for military aircraft. This industry was located in Troy, Ohio. Goodrich had developed a new and innovative design: a four-rotor brake that would be considerably lighter than the more traditional five-rotor design. Any reduction in weight is very attractive in aircraft design, since it allows for an increase in payload weight with no decrease in performance.

Example: The Goodrich A7-D Brake Case *[read also Fleddermann pp 114-116; full text here]*

In June of 1967, Goodrich was awarded the contract to supply the brakes for the A7-D by LTV, the prime contractor for the airplane. The qualifying of this new design was on a very tight schedule imposed by the Air Force. The new brake had to be ready for flight testing by June of 1968, leaving only one year to test and qualify the design. To qualify the design for the flight test, Goodrich had to demonstrate that it performed well in a series of tests specified by the Air Force.

After the design had been completed, John Warren, the design engineer, handed the project over to Searle Lawson, who was just out of engineering school, to perform the testing of the brakes. Warren moved on to other projects within the corporation. Lawson's first task was to test various potential brake-lining materials to see which ones would work best in this new design. This test would be followed by the testing of the chosen linings on full-scale prototypes of the brakes. Unfortunately, after six months of testing, Lawson was unable to find any materials that worked adequately. He became convinced that the design itself was flawed and would never perform according to the Air Force's specifications.

Example: The Goodrich A7-D Brake Case *[read also Fleddermann pp 114-116; full text here]*

Lawson spoke with Warren about these problems. Warren still felt that the brake design was adequate and made several suggestions to Lawson regarding new lining materials that might improve performance. However, none of these suggestions worked and the brakes still failed to pass the initial tests. Lawson then spoke about these problems with Robert Sink, the A7-D project manager at Goodrich. Sink asked Lawson to keep on trying some more linings and expressed confidence that the design would work correctly.

In March of 1968, Goodrich began testing the brake prototypes. After 13 tests, the brake had yet to pass the Air Force's specification for temperature. The only way to get the brakes to pass the test was to set up cooling fans directed at the rotors. Obviously, brakes that required extra cooling would not meet the Air Force's specification. Nevertheless, Sink assured LTV that the brake development was going well.

Example: The Goodrich A7-D Brake Case *[read also Fleddermann pp 114-116; full text here]*

Kermit Vandivier was a technical writer for Goodrich who was responsible for writing test reports and was assigned to write the report for the new A7-D brakes. This report would be an integral part of the Air Force's decision-making process. Vandivier was not an engineer, but he did have experience in writing up the results of this type of test. In the course of writing the report on the A7-D brake tests, Vandivier became aware that some of the test results had been rigged to meet the Air Force's specifications. Vandivier raised his concerns about the report he was writing, feeling that he couldn't write a report based on falsified data. His attempts to write an accurate report were not allowed by management, and Goodrich submitted a report using the jury-rigged data. Based on this report, the brake was qualified for flight testing.

Vandivier was concerned about the safety of the brake and wondered what his legal responsibility might be. He contacted his attorney, who suggested that he and Lawson might be guilty of conspiracy to commit fraud and advised Vandivier to meet with the U.S. Attorney in Dayton. Upon advice of the U.S. Attorney, both Lawson and Vandivier contacted the FBI.

Example: The Goodrich A7-D Brake Case *[read also Fleddermann pp 114-116; full text here]*

In July, the Air Force asked Goodrich to supply the raw test data for review. This request led to efforts at Goodrich to control the damage that would ensue when the real nature of the tests became known. Not being satisfied with the report presented to it, the Air Force refused to accept the brake. Knowing that the four-rotor brake was not going to work, Goodrich began an effort to design a five-rotor replacement. Vandivier continued meeting with the FBI and supplied FBI agents with Goodrich documents related to the A7-D brake tests.

Apparently, Lawson had impressed LTV because after the flight testing was over, LTV offered him a job. Lawson accepted and left Goodrich on October 11, 1968. With the only other person who really knew about the test procedures gone, Vandivier also decided to resign from Goodrich. In his letter of resignation, he included a series of accusations of wrongdoing against Goodrich regarding the brake tests. Vandivier went to work for the *Troy Daily News*, the local newspaper.

Example: The Goodrich A7-D Brake Case *[read also Fleddermann pp 114-116; full text here]*

At the *Daily News*, Vandivier told his editor about the situation at Goodrich. From there, the story made its way to Washington, where it came to the attention of Senator William Proxmire, among others. In May of 1969, Proxmire requested the General Accounting Office (GAO) review the issue of the qualification testing of the A7-D brakes. The GAO investigation led to an August 1969 Senate hearing chaired by Proxmire. By then, the new five-rotor brake had been tested and qualified for use on the A7-D. At the hearing, Vandivier's concerns and the GAO findings were publicly aired. The GAO report confirmed Vandivier's statements about testing discrepancies, though the report also showed that there was no additional cost to the government in obtaining a working brake and that the brake problems didn't cause any substantial delays in the overall A7-D program.

No official action was taken against Goodrich as a result of this incident, and there does not seem to have been any negative impact on the careers of those at Goodrich involved in the A7-D project. Lawson went on to a successful career at LTV. Vandivier later wrote a chapter of a book and an article in Harper's magazine detailing his version of the story.

Space Shuttle *Challenger* disaster

© Wikipedia

From Wikipedia, the free encyclopedia

Coordinates: 28°38'24"N 80°16'48"W

The **Space Shuttle *Challenger* disaster** occurred on January 28, 1986, when Space Shuttle *Challenger* (mission STS-51-L) broke apart 73 seconds into its flight, leading to the deaths of its seven crew members. The spacecraft disintegrated over the Atlantic Ocean, off the coast of Cape Canaveral, Florida at 11:38 EST (16:38 UTC). Disintegration of the vehicle began after an O-ring seal in its right solid rocket booster (SRB) failed at liftoff. The O-ring failure caused a breach in the SRB joint it sealed, allowing pressurized hot gas from within the solid rocket motor to reach the outside and impinge upon the adjacent SRB attachment hardware and external fuel tank. This led to the separation of the right-hand SRB's aft attachment and the structural failure of the external tank. Aerodynamic forces broke up the orbiter.

The crew compartment and many other vehicle fragments were eventually recovered from the ocean floor after a lengthy search and recovery operation. The exact timing of the death of the crew is unknown; several crew members are known to have survived the initial breakup of the spacecraft. The shuttle had no escape system, and the impact of the crew compartment with the ocean surface was too violent to be survivable.

The disaster resulted in a 32-month hiatus in the shuttle program and the formation of the Rogers Commission, a special commission appointed by United States President Ronald Reagan to investigate the accident. The Rogers Commission found NASA's organizational culture and decision-making processes had been key contributing factors to the accident.[1] NASA managers had known contractor Morton Thiokol's design of the SRBs contained a potentially catastrophic flaw in the O-rings since 1977, but failed to address it properly. They also disregarded warnings (an example of "go fever") from engineers about the dangers of launching posed by the low temperatures of that morning and failed to adequately report these technical concerns to their superiors.

What Rogers did not highlight was that the vehicle was never certified to operate in temperatures that low. The O-rings, as well as many other critical components, had no test data to support any expectation of a successful launch in such conditions. Bob Ebeling from Thiokol delivered a biting analysis: "[W]e're only qualified to 40 degrees ...'what business does anyone even have thinking about 18 degrees, we're in no man's land.'"[2]

Space Shuttle *Challenger* disaster

Space Shuttle *Challenger*'s smoke plume after its in-flight breakup, resulting in its destruction and the deaths of all seven crew members.

Date	January 28, 1986
Time	11:39:13 EST (16:39:13 UTC)
Location	Atlantic Ocean, off the coast of central Florida
Outcome	Grounding of the Space Shuttle fleet for nearly three years during which various safety measures, solid rocket booster redesign, and a new policy on management decision-making for future launches were implemented.

Casualties

Francis R. Scobee, Commander
Michael J. Smith, Pilot
Ronald McNair, Mission Specialist
Ellison Onizuka, Mission Specialist
Judith Resnik, Mission Specialist
Greg Jarvis, Payload Specialist
Christa McAuliffe, Payload Specialist

Inquiries Rogers Commission

NUS National University of Singapore

Read also the more detailed article, available as a free download from Wikipedia©, which is also in "Assigned Readings" IVLE Folder...

Aberdeen Proving Ground

Aberdeen Proving Ground	
Part of US Army	
Aberdeen, Maryland	
	
Aberdeen Proving Ground Historical Marker on US 40	
Site information	
Owner	US Army
Site history	
Built	1917
In use	1917 to Present
Garrison information	
Current commander	Colonel Charles Gibson (Acting)
Past commanders	Major General Robert S. Ferrell
Garrison	Colonel Gregory R. McClinton

Aberdeen Proving Ground (APG) (sometimes erroneously called Aberdeen Proving *Grounds*) is a United States Army facility located in Aberdeen, Maryland, (in Harford County). Part of the facility is a census-designated place (CDP), which had a population of 3,116 at the 2000 census.

History

APG is the U.S. Army's oldest active proving ground, established on October 20, 1917, six months after the U.S. entered World War I. Its location allowed design and testing of ordnance materiel to take place near contemporary industrial and shipping centers. The proving ground was created as a successor to the Sandy Hook Proving Ground, which was too small for some of the larger weapons being tested. At the peak of World War II, APG had billeting space for 2,348 officers and 24,189 enlisted personnel.

The Edgewood area of Aberdeen Proving Ground is approximately 13,000 acres and includes Gunpowder Neck, Pooles Island, Carroll Island, and Graces Quarters. The Edgewood area was used for the development and testing of chemical agent munitions. From 1917 to the present, the Edgewood area conducted chemical research programs, manufactured chemical agents, and tested, stored, and disposed of toxic materials. There are 38,600 people living within three miles of the site. On-site residences house military personnel and military dependents.

Read also the more detailed article, available as a free download from Wikipedia©, which is also in "Assigned Readings" IVLE Folder...

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TOPIC 1 – Introduction (Issues)

- **THL1.1 - Some Background & Preliminaries**
- **THL1.2 - Why Study Engineering Ethics?**
- **THL1.3 - Origins of Ethical Thought – Some Pertinent Points**
- **THL1.4 - Ethics Problems -- Like Engineering Design Problems? How so?**
- **THL1.5 - Illustrative Cases (Homework Reading!!!)**
- **THL1.6 - Summary (I)**

Reference Reading: *Fleddermann* 4th Ed Chapter 1

THL1.6 - Summary (I)

- ***Engineering ethics is the study of moral decisions that must be made by engineers in the course of engineering practice. It is important for engineering students to study ethics so that they will be prepared to respond appropriately to ethical challenges during their careers.***

- ***Often, the correct answer to an [engineering] ethical problem will not be obvious and will require some analysis using ethical theories. [We will study, and also learn to use, suitable "ethical theories" in Lecture 2!! And several "ethical decision tools" in Lecture 3.]***

THL1.6 - Summary (I)

- ***The types of problems that we will encounter in studying engineering ethics are very similar [in their nature] to the design problems that engineers work on everyday. [This part is rather obvious!! I skipped this part of the book.] As in design, there will not be a single correct answer.***

- ***Engineering ethics problems will have multiple correct solutions, with some solutions being better than others.***

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Reference Reading: *Fleddermann* 4th Ed Chapter 1

THL1.1 - Some Background & Preliminaries - LECTURES (24 Hours)

NUS National University of Singapore

➢ 1. Introduction (Issues)	- 2 Hrs (T.H.Lee)
➢ 2. Ethical Theories	- 2 Hrs (T.H.Lee)
➢ 3. Ethical Problem Solving Techniques	- 2 Hrs (T.H.Lee)
➢ 4. Engineer at the Workplace	- 2 Hrs (Kevin Kuang)
➢ 5. Academic and Research Ethics	- 2 Hrs (Kevin Kuang)
➢ 6. Role of Professional Societies	- 2 Hrs (Kevin Kuang)
➢ 7. Commitment to Safety	- 2 Hrs (K.G.Neoh)
➢ 8. International Engineering Professionalism	- 2 Hrs (K.G.Neoh)
➢ 9. Engineers and the Environment	- 2 Hrs (K.G.Neoh)
➢ 10. Intellectual Property Rights (LAW)	- 6 Hrs (Oliver Quek)

And (looking ahead!!) similar to what I do for all my modules:

Prof T.H.Lee's volunteer ***optional*** extra review/revision classes ---
- on Saturday 23 Oct 2021, 3pm-4.30pm (Week 11, for EG2401a)
- Venue: **ZOOM (I will confirm details again nearer those times!)**

Then, I will review with you all again, the major concepts for my portion of the module (with perhaps detailed descriptions of an additional *new* practice Case Study!!); because by that later time, it is likely that much needs to be illumined again!! :-):-) But note that it is entirely ***optional***, for those who wish to avail themselves of this. And perhaps of greater gravitas now to EG2401a, showcasing samples of how an effective EG2401(a) project can be assembled…

I will remind nearer that time. :-):-)

A suitable "rejoinder" here... at this outset...

NUS National University of Singapore

"Forget not… professionalism & ethics is not just nice-to-hear only… it is for do-ing!!!"

The story is often told of how the then-new democracy in the new America was formed, naturally paraphrased [by me, lah!! ☺☺] here. The learned gentleman Benjamin Franklin had just come out of Independence Hall, having spent much time there with his co-workers in formulating the new American Constitution. A lady stopped him outside, and asked, "Pray, tell us Sir; what manner of government have you bequeathed us?" To which the learned gentleman thought for a while, and then replied, "A democracy with respect, rights and equal-opportunity for all, my good lady; but only if you all will yourselves keep it that way."

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