Examples on complex engineering problems and activities in CSE

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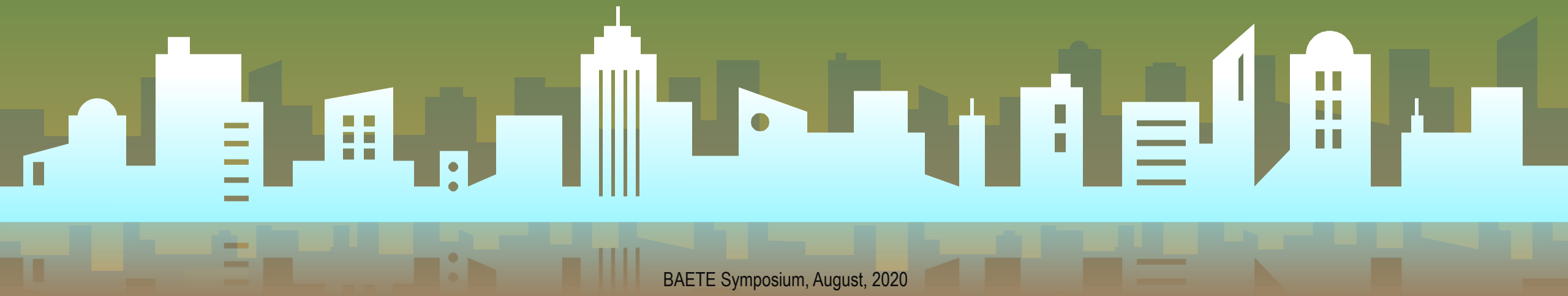


Learning Outcomes

- ❑ Present an example of COs and CO-PO mapping for the FYDP course of a CSE program
- ❑ Demonstrate that Complex Engineering Problems can be attained through FYDP or projects completed in courses
- ❑ Present two projects—one software based and another hardware based
  - Students will be exposed to Complex Engineering Problems through these types of projects
- ❑ Demonstrate necessary mappings of the complex engineering problems (Ps) and complex engineering activities (As) for these two projects
  - Mapping between Ps and CO-PO of FYDP is also shown

Example CO-PO of Final-Year Design Project (FYDP)

COs	Description	PO	Assessment
CO1	Identify a real-life problem that can be translated to an engineering and/or computing solution through design, development and validation	(l) Life-long learning	Report
CO2	Identify outcomes and functional requirements of the proposed solution considering software and/or hardware specification and standards	(b) Problem analysis (c) Design/development	Report
CO3	Identify sub-components of a complex problem, prepare timeline and appropriate budget using the project management skill	(k) Project management and finance	Report
CO4	Analyze, design, build, and evaluate engineering/computing system/subsystem with given specifications and requirements	(c) Design/development (d) Investigation	Report, Project demo
CO5	Identify and validate the impact of environmental considerations and the sustainability of a system/subsystem of a complete project	(g) Environment and sustainability	Report
CO6	Assess professional, ethical, and social impacts and responsibilities of the design project	(f) The engineer and society (h) Ethics	Report
CO7	Function effectively in a multi-disciplinary team	(i) Individual work and teamwork	Reflective Journal, Peer-evaluation
CO8	Use modern analysis and design tools in the process of designing and validating of a system and subsystem	(e) Modern tool usage	Project demo, Presentation
CO9	Present design project results through written technical documents and oral presentations	(j) Communication	Report, Presentation

Example 1: A project carried out by the students in their FYDP course.

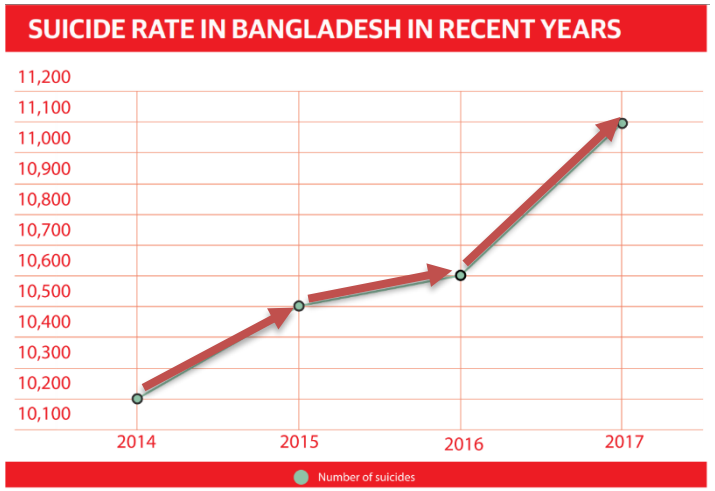
Motivation: In Bangladesh, depression is found In 2.6-5.5% among men and 6.0-11.8% among women, which causes the increased suicide rate. Early notification of depression can reduce the disease burden.

Objective: A machine-learning based model will be developed to predict the early depression of the patients from their activities in social media.

- The model will be trained first using data collected from random users.
- A web- or app-based front end will be developed to use the model.

Critical challenges: Various social media data will not be used as Facebook is the mainstream social media in Bangladesh. Willingness of users to participate while correctness of the model depends on availability of large data set. Maintaining privacy of the users' data.

Conflicting requirements: Develop a practical machine learning model with proper regularization with low variance while limited social media data (only from Facebook) will be used.



Addressing Complex Engineering Problems (Ps) through this project

We explore how a few P's are addressed through this project

- P1: Project requires study of existing models with similar goals (K8), data collection from social media (K3, K4), knowledge of design of machine-learning based model (K3, K4), web-based front end (K6) and integration of different components (K5, K6).
- P2: Conflicting technical requirements: machine learning model with proper regularization and low variance while limited social media data will be available.
- P3: No obvious formulation as a machine-learning problem due to the availability and variations of social media data. Depth of analysis needed to select a specific algorithm from many alternatives.
- P4: Computer science and engineering graduates are not typically exposed to issues related to mental health or depression.
- P7: Project involves a number of interdependent sub-systems (components), such as, data collection, training module, detection module, front-end application development, etc.

Knowledge Profiles (K)

K – short name
K1 – natural sciences
K2 – mathematics
K3 – engineering fundamentals
K4 – specialist knowledge
K5 – engineering design
K6 – engineering practice
K7 – comprehension
K8 – research literature

Attribute	P1 and some or all of P2 to P7:
Depth of knowledge required	**P1**: one or more of K3, K4, K5, K6 or K8
Range of conflicting requirements	**P2**: wide-ranging or conflicting technical, engineering and other issues
Depth of analysis required	**P3**: no obvious solution
Familiarity of issues	**P4**: Involve infrequently encountered issues
Extent of applicable codes	**P5**: outside problems encompassed by standards and codes of practice
Extent of stake-holder involvement and conflicting requirements	**P6**: diverse groups of stakeholders with widely varying needs
Interdependence	**P7**: many component parts or sub-problems

Mapping between Ps and COs of FYDP

Description of Ps	Mapping to CO-PO
P1: Project requires study of existing models with similar goals (K8), data collection from social media (K3, K4), knowledge of design of machine-learning based model (K3, K4), web-based front end (K6) and integration of different components (K5, K6).	CO2-PO(b) Problem analysis CO2-PO(c) Design/development CO4-PO(c) Design/development CO4-PO(d) Investigation CO8-PO(e) Modern tool usage
P2: Conflicting technical requirements: machine learning model with proper regularization and low variance while limited social media data will be available.	CO2-PO(c) Design/development CO4-PO(c) Design/development CO4-PO(d) Investigation
P3: No obvious formulation as a machine-learning problem due to the availability and variations of social media data. Depth of analysis needed to select a specific algorithm from many alternatives.	CO4-PO(c) Design/development CO4-PO(d) Investigation
P4: Computer science and engineering graduates are not typically exposed to issues related to mental health or depression.	CO6-PO(f) The engineer and society
P7: Project involves a number of interdependent sub-systems (components), such as, data collection, training module, detection module, front-end application development, etc.	-

Addressing Complex Activities (As) through this project

We explore how a few As are addressed

- A1: The project needs to engage diverse resources including people, money, information and technologies.
- A2: A good level of interaction is needed among the students, the health professionals and the participants.
- A3: A degree of innovation is needed to develop the machine-learning based depression prediction model using the available data.
- A5: The project deals with a new area for computer science and engineering graduates.

Attribute	Some or all of the following:
Range of resources	A1: use of diverse resources (include people, money, equipment, materials, information and technologies)
Level of interaction	A2: resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues
Innovation	A3: creative use of engineering principles and research based knowledge in novel ways
Consequences for society and the environment	A4: consequences in a range of contexts, characterized by difficulty of prediction and mitigation
Familiarity	A5: Can extend beyond previous experiences by applying principles-based approaches

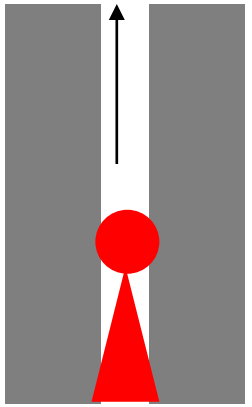
A Different Problem from a combination of Hardware and Human Computer Interaction

Motivation: By a real life problem of an elevator accident mentioned in Figure A.

Problem Definition

Once the elevator door closes it ensures safety inside the elevator. Once the elevator decides to close the door (and make a next move), it cannot be opened. The goal of the project was to use external hardware and software system to force open the door in case of emergency.

- **Human Computer Interaction:** Understanding the importance and impact from user studies how elderly or vulnerable people are hit by lift doors or sudden miss of sensors.
- **Hardware part:** Design and development of anti-snap door opening system that works against the force that closes the doors.
- **Software part:** A mobile component to support the system and livestream the elevator data continuously.



A kid got stuck In elevator door
- was dragged to next floor
- Elevator could not be stopped

Figure A.
Kid trapped in elevator door

Can we Please identify few Ps and Ks that might be useful?

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I need help, please!

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Extent of stake-holder involvement and conflicting requirements	**P6**: diverse groups of stakeholders with widely varying needs
Interdependence	**P7**: many component parts or sub-problems

Problem ranges (P) that are addressed through this project

We explore how a few P's are addressed through this project

- P1: **Depth of knowledge** covers the following aspects:
  - study of research on accident handling of elevators (k8)
  - data collection from user studies, survey (K7),
  - knowledge of hardware & software knowledge (K3, K4)
  - engineering design (K5) and development (K6)
- P2: **Conflicting technical engineering and other issues** sensor response vs accuracy to detect;
- P3: **No obvious formulation** as it was triggered based on a recent accident. It had to look at alternative designs, internal or external, trigger etc.
- P4: **Infrequently encountered issues** They needed mechanical engineering and Electronics, not usual for CSE students
- P7: Project involves **high level problems** Subsystems (microcontroller module , sensors module software module etc.) worked independently, later coordinated

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Activities (A) that are addressed through this project

We explore how a few A's are addressed through this project

(Think about a sales pitch in your mind), thanks Dr. Anisul Haque

- **A1: The project needs to engage diverse resources including people (survey), money (component of consideration), information and technologies (electronics, mechanical).**
- **A2: Software and hardware part needed integration and close collaboration. Student communication, HCI research communication, continued teamwork … conflict resolution among team members**
- **A4: Considering vulnerable population (e.g., children, elderly people etc.) impact on society, accident prevention.**
- **A5: The project deals with a new area for computer science and engineering graduates.**

Deliverable: The complete elevator system prototype (6 ft high)

Attribute	Complex activities means activities or projects that have some or all of the following:
Range of resources	**A1**: use of diverse resources (include people, money, equipment, materials, information and technologies)
Level of interaction	**A2**: resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues
Innovation	**A3**: creative use of engineering principles and research based knowledge in novel ways
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Thank You