A Perfect IS Capstone Experience for HIM and HER

12th SoC Teaching Luncheon

9th December 2014
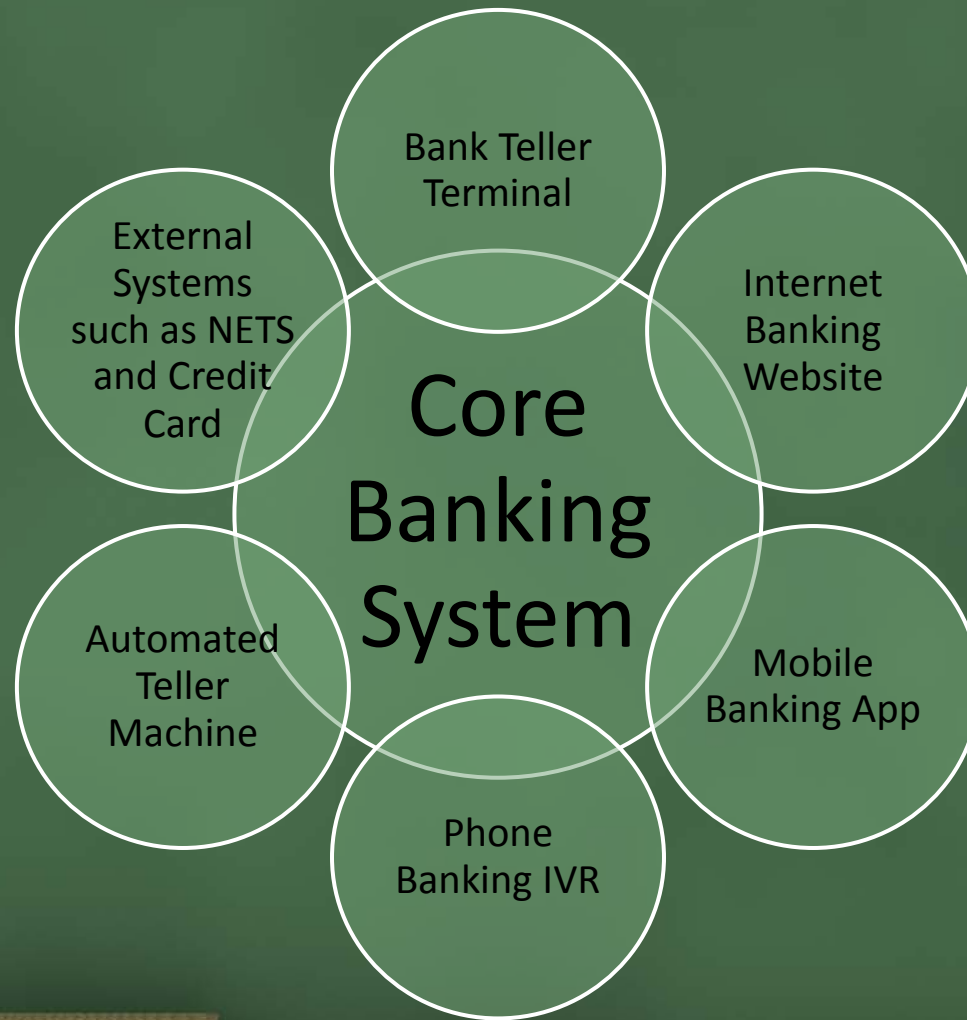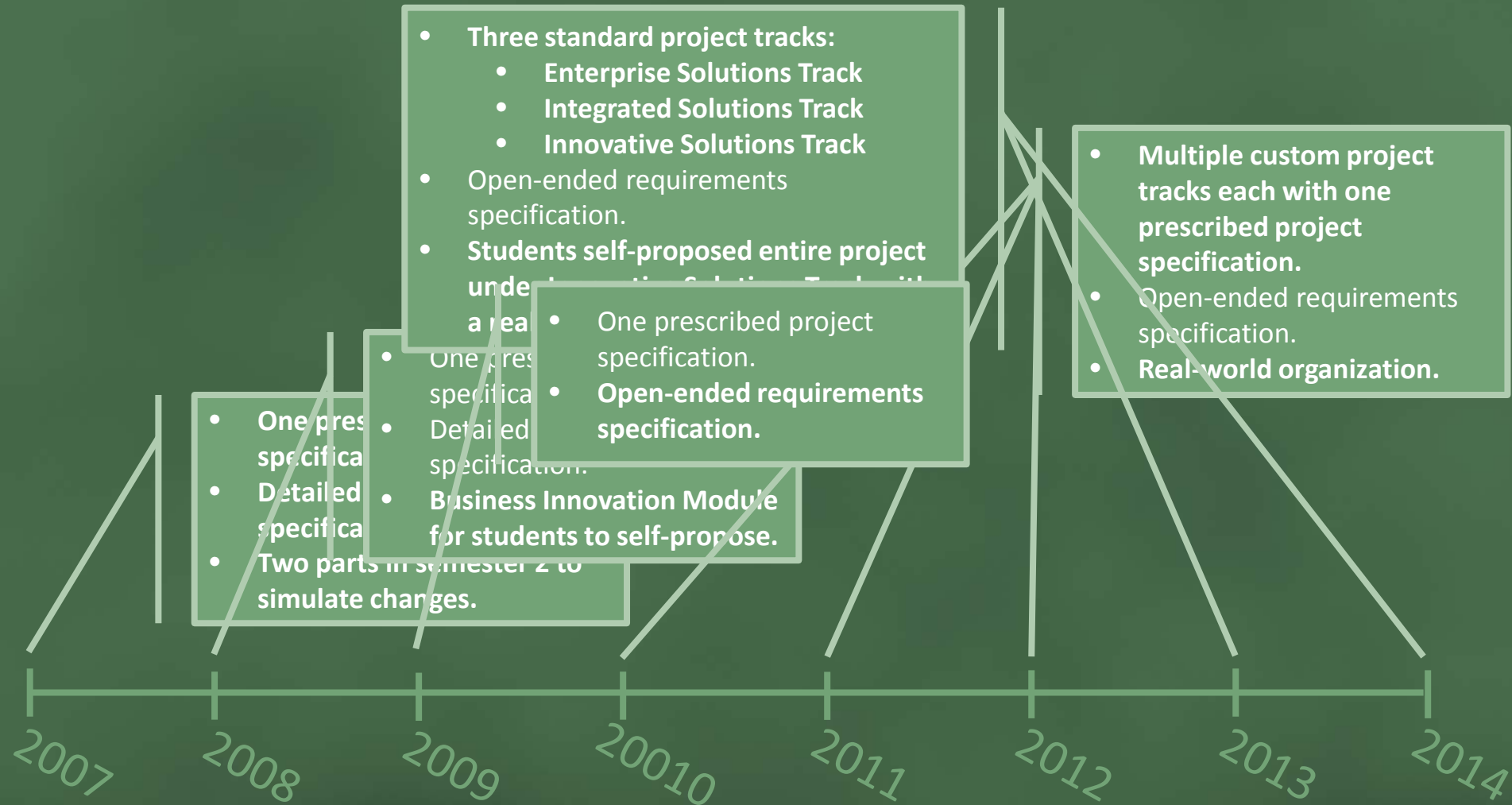
Tan Wee Kek

IS3102

What is IS3102?

- **Capstone project** module for IS majors.
- 8 MC 100% evaluative project-based module.
- Balanced emphasis on business and technical aspects.
- Students work in teams of 6 members to undertake a complete system development lifecycle.
- Main deliverable is a large-scale enterprise information system:
  - Notion of a core backend developed using component-based software engineering (CBSE).
  - Multiple applications accessing the core backend to perform enterprise data management and transaction processing.

What is IS3102? (cont.)

Evolution of IS3102

Three standard project tracks:
- **Enterprise Solutions Track**
- **Integrated Solutions Track**
- **Innovative Solutions Track**

Open-ended requirements specification.

Students self-proposed entire project under Innovative Solutions Track with a real...

- **Multiple custom project tracks each with one prescribed project specification.**
- Open-ended requirements specification.
- **Real-world organization.**

- One prescribed project specification.
- **Open-ended requirements specification.**

- One pres... specificat...
- Detailed... specificat...
- **Business Innovation Module for students to self-propose.**

- **One pres... specifica...**
- **Detailed... specifica...**
- **Two parts in semester 2 to simulate changes.**

2007 2008 2009 20010 2011 2012 2013 2014

Evolution of IS3102 - Summary

Year	Project Track	Characteristics
2007	No – One prescribed project specification.	• Detailed requirements specification. • Two parts in S2 to simulate changes.
2008	No – One prescribed project specification.	• Detailed requirements specification. • Business Innovation Module for students to self-propose.
2009	No – One prescribed project specification.	• Open-ended requirements specification.
2010 – 2012	Yes – Multiple custom project tracks each with one prescribed project specification.	• Open-ended requirements specification. • Real-world organization.
2013 – 2014	Yes – Three standard project tracks: • Enterprise Solutions Track • Integrated Solutions Track • Innovative Solutions Track	• Open-ended requirements specification. • Students self-proposed entire project under Innovative Solutions Track with a real-world organization.

Project Specification Design

- Detailed requirements specification:
  - Even database attributes are provided.

1. Client Profile Creation and Updating

The system shall provide functionality for users to create new client profile that capture a rich set of information. The system shall also allow the various types of information to be accessed, updated and printed out.

Typically, a new client profile is created by a financial advisory expert when a client is solicited successfully. In such case, the expert will enter a complete set of profile information. However, sometime a new client may simply walk-in or call-up to make an unsolicited enquiry. In such cases, the employee serving the client at the contact point will only enter a preliminary profile consisting of only personal information. The remaining sections of the client profile may be completed at a later time when an expert follows up on the case (to be explained in section N on Case Management Module).

There are generally six sections of information as detailed below:

1.1. **Section A – Personal Information**: This section of the client profile consists of ordinary personal particulars such as, but is not limited to, the following fields:
- Salutation
- Surname/family name
- Given name
- Alias
- Nationality
- NRIC passport number
- Race/Ethnic
- Religion
- Local residential address
- Local contact numbers (home, office, mobile, pager and fax)
- Overseas residential address and contact numbers (multiple sets)
- Marital status
- Date of birth
- Education information/qualification (multiple sets)
- Personal interests/hobbies (customizable from an available list of predefined categories, e.g. food preferences, car preferences, sport preferences, etc)

Project Specification Design (cont.)

- Business Innovation Module:
  - Characterized by small-scale open-ended requirements.

E.9. Business Innovation Module

This is a **COMPLEX** module, which is **OPTIONAL**, and contains <u>1 AAU</u>. To attempt this module, you must ensure that your team has fully completed the functional requirements specification for E.1 to E.8. Otherwise, the credit for the AAU in this module will be forfeited. Thus, please seek approval from your team advisor before attempting this module.

E.9.1. Business Innovation Module

1. **Business Innovation Module** – In response to a special request from EPL, your colleagues in KRT and you have been asked to provide consultancy service to EPL as part of the contract. Specifically, EPL has requested your team to brainstorm an additional functional module to assist them in making their new start-up ASP solution company a definite and resounding success. The module may either be for the BMPS or the Portal. The module must provide at least <u>3</u> functionalities that produce tangible outputs and must not overlap with any of the existing functionalities.

Essentially, EPL is looking out for that elusive module IX that will give them a strategic competitive advantage over other existing and potential ASP solution providers. A strategic competitive advantage here refers to a unique business process that can allow EPL to better serve its customers either more efficiently or effectively; or to provide additional innovative services that can increase the revenue base of the company. Regardless, the strategic competitive advantage places EPL in a better position to compete with its competitors. Furthermore, the advantage should not be easily imitable and is sustainable in the medium to long term. By acquiring a strategic competitive advantage, EPL will establish itself firmly in the commercial training and education industry and thereby raise the entry barrier for potential competitors.

Generally, you should approach the problem from the perspective of EPL, i.e. you must understand how any proposed module can improve the bottom line of EPL's corporate customers. It is only when this condition is met will the educational establishments be more willing to subscribe to EPL services instead of another competitor. You should explore the possibility of using both existing and new technologies such as business intelligence, decision support and web services to create functionalities that can enhance existing business processes or even create a new one to achieve business innovation in EPL and its corporate clients. Do not propose yet another "boring" data entry module. We are looking for that creative spark!

Project Specification Design (cont.)

- Open-ended requirements specification:
    - Students are provided with description of the business domain and system domain.
    - Complex domains that are unfamiliar to students:
        - Hospital information system.
        - Fifth-party logistics.
    - Actual requirements are worded briefly and vaguely.
    - Ambiguities, conflicts and "traps" are deliberately injected to force students to think and analyze the problem.

Project Specification Design (cont.)

B. PROJECT TRACK DOMAINS

B.1. Business Domain

B.1.1. Overview of Logistics and Supply Chain Management

In the simplest terms, **logistics** refer to the management of the flow of goods between the point of origin and the point of consumption in order to meet customers' requirements[7]. Point of origin may refer to the place of extraction of raw materials in the case of primary industry or place of manufacturing in the case of secondary industry. The point of consumption may refer to end consumers in the case of business-to-consumer (B2C) trade activities. In the case of business-to-business (B2B) trade activities, the point of consumption may be factories for further processing or consumption by corporate customers.

Goods may be in various stages of processing, from unprocessed raw form to fully finished goods ready for immediate consumption – physical goods, such as food, materials, animals, equipment and liquids, as well as abstract goods, such as time, information, particles, and energy. Conventional logistics involving physical goods usually requires the integration of information flow, material handling, production, packaging, inventory, transportation and warehousing. Logistics emphasizes on minimizing the use of resources in moving goods. From a process perspective, logistics involves planning, implementing, and controlling the effective and efficient flow of goods and services from the point of origin to the point of consumption. The gist of business logistics can best be summarized as *"having the right item in the right quantity at the right time at the right place for the right price in the right condition to the right customer"*.

Logistics consists of two main processes. Inbound logistics focuses on purchasing and arranging the inbound movement of materials, parts, and finished inventory from suppliers to manufacturing or assembly facilities, warehouses, or retail stores. Outbound logistics process involves storage and movement of the final product and the related information flows from the end of the production line to the end user.

A closely related concept is **supply chain management (SCM)**. SCM also refers to the management of the flow of goods[8]. But it applies more specifically to the manufacturing industry. SCM involves the movement and storage of raw materials, work-in-process inventory, and finished goods from point of origin to point of consumption. SCM assumes the existence of a distribution network, i.e., supply chain, consisting of nodes representing a manufacturer and its upstream and downstream partners. Upstream partners are suppliers of raw materials and parts/assemblies necessary for manufacturing of a particular good. Downstream partners are the distributors responsible for bringing the finished good to the end consumers. Figure B.1 shows a supply chain for a laptop manufacturer.

B.2. System Domain

B.2.1. Supply Chain Management Systems

A combination of different computerized information systems may be utilized to manage and improve a complex supply chain network. Some of the commonly used information systems include Order Management Systems, Warehouse Management System, Transportation Management Systems, Inventory Management Systems, Replenishment Systems and more. Emerging technologies and standards such as the RFID and the GS1 Global Standards also make it possible to automate the management of a supply chain network.

Supply Chain Management (SCM) systems refer to the set of information systems that continuously link the activities of buying, making and moving products from suppliers to purchasing firms, as well as integrating the demand side of the business equation by including the order entry system in the process. SCM systems coordinate the activities of suppliers, shippers and order entry systems to automate order entry through production, payment and shipping business processes. Customers and employees are increasingly using smartphones and mobile applications to place and coordinate orders. A high-level SCM systems framework is shown in Figure B.6.
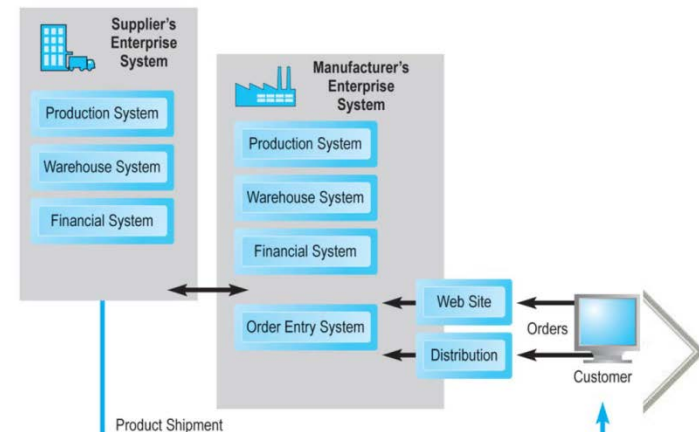

Figure B.6 – A high-level framework of Supply Chain Management systems (Source: E-Commerce 2014, pp. 808, Figure 12.6)

The manufacturer's enterprise system referenced in Figure B.6 is essentially the manufacturer's Enterprise Resource Planning (ERP) system. Indeed, another framework of

Project Specification Design (cont.)

## C.7. Transportation Management System (TMS)

The TMS is used by both Merlion Logistics and its clients to manage their transportation assets and processes. In the case of Merlion Logistics, the TMS will be used to manage its fleet of land-based and sea-based transportation assets mainly for providing last-mile connectivity. These transportation assets are distributed globally. For land-based assets, they can also be used for providing long-haul transportation on road.

In the case of Merlion Logistics's clients, the TMS is used for managing their own transportation assets, which can be any long-range or short-range assets. For 2PL and asset-based 3PL service providers, TMS is a very important information system. This is because the TMS will be used to manage the dispatch of assets to fulfill transportation service contracts and orders of their customers. 1PL clients will typically be using the TMS to manage their own assets, if any, and for requesting for transportation services from other higher-level logistics service providers.

There are other advanced functionalities that the TMS should provide in the future. For instance, the TMS should manage human resources such as transport operators as well as

Project Specification Design (cont.)

- An example of conflicting requirements deliberately injected into the project specification:
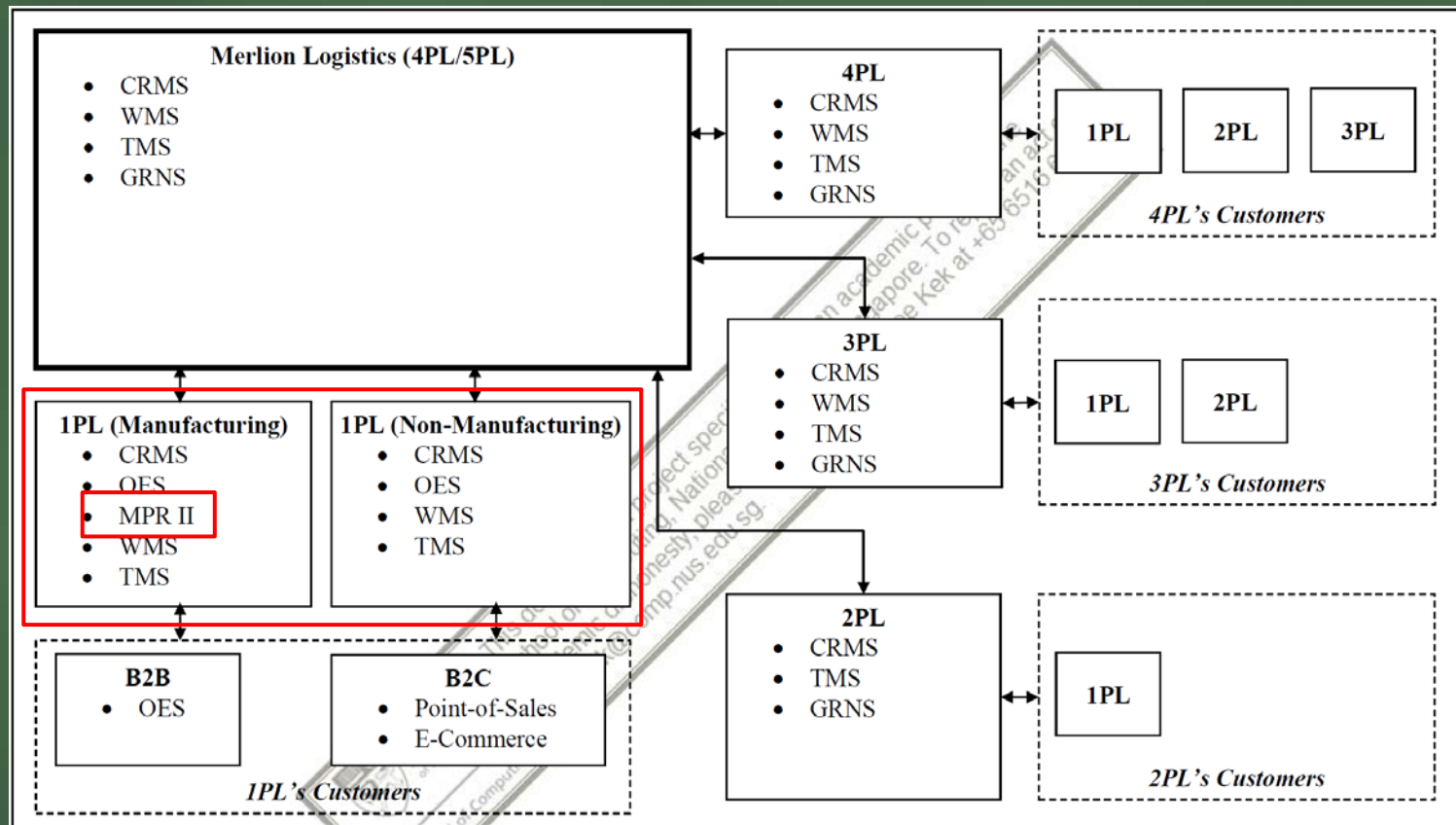
Project Specification Design (cont.)

C.5. Manufacturing Resource Planning System (MRP II)

The MRP II system is typically used only by 1PL clients that are involved with manufacturing. The MRP II system should allow the client to perform the entire production planning process depicted in Figure B.10. This system should be tightly integrated with the OES to ensure that sales forecast are accurate and reflect prevailing purchase patterns.

It is not necessary for the MRP II system to handle actual production lines configuration and scheduling. Consequently, the system does not need to manage the production and packing parameters of goods. However, in order to facilitate the materials requirements planning process, the system should maintain the BOM of each good.

The MRP II system needs to be tightly integrated with both the WMS and TMS for managing inbound and outbound logistics processes. In a typical scenario, a 1PL will need to place order for raw materials or parts from its supplier. This involves arranging suitable transport to move the raw materials from the supplier's premise to the 1PL's premise. After receiving the raw materials, the WMS will be used to place them into available storage bins. During production, the raw materials will need to be moved from the warehouse to the production line. Unused raw materials will need to be returned back to the warehouse. Finally, completed goods need to be kept in the warehouse and recorded in the WMS. When a sales order has been made, the completed goods will need to be picked up from the warehouse and shipped to the customer. This order fulfillment process will again involve the WMS and TMS.

The MRP II system is provided as a software service via the SaaS model for use by 1PL clients. As such, the MRP II system must be designed to accommodate a generic production process for any manufacturing industry, e.g., food & beverage, consumer electronics and furniture.

Project Specification Design (cont.)

- The figure seems to suggest that a 1PL non-manufacturing entity does not need to use the MRP II system altogether.

- However, the requirements specification for MRP II makes reference to "purchasing functionalities".

- A 1PL non-manufacturing entity will still need to "purchase" its goods for suppliers.

- Does not make sense to have duplicated "purchasing functionalities" in different systems.

- So if "purchasing functionalities" are in the MRP II system, a 1PL non-manufacturing entity will still need to use it.

Multiple Project Tracks

- In the past with a single prescribed project specification, students feedback that the project was:
  - "boring, uninteresting and lacked realism".
  - "everyone was working on the same project."
- Between 2010 – 2012, we offered multiple custom project tracks for each semester:
  - One project track with a prescribed project specification for mainstream enterprise information system based on fictitious organization.
  - One or more project tracks each with a prescribed project specification for mainstream or custom enterprise information system based on real-world organization.

Multiple Project Tracks (cont.)

- Examples:
  - In 2010, we offered three project tracks:
    - Organizational Track – Graduate Admission System for a fictitious University
    - Entrepreneurship Track – Online B2B marketplace for Alpha Global Commodity Solutions, a local startup dealing with electronic components and parts.
    - Electronic Commerce Track – Online B2C marketplace for Yixing Huayuan Bamboo & Wood Industry Co. Ltd., a leading manufacturer of bamboo products based in China.
  - In 2011, we offered two project tracks:
    - Manufacturing Track – Enterprise Resource Planning for a fictitious food manufacturer.
    - Tourism Track – National tourism portal for a local TCube Ventures Pte. Ltd., a local It company specializing in the tourism industry.

Multiple Project Tracks (cont.)

- From 2013 onwards, we offered <u>three standard project tracks</u>:

  - **Enterprise Solutions Track**:

    - Mainstream enterprise information system.

    - Mainly web-based applications.

  - **Integrated Solutions Track**:

    - Customized information system.

    - Integration with various hardware such as smartphone, tablet, NFC, RFID, GSM modem and Point-of-Sale.

    - Web-based and other applications such as mobile app, desktop application and smartcard application.

  - **Innovative Solutions Track**:

    - Students self-propose a suitable project with a real-world organization.

    - Final deliverable is a technological solution comprising of at least a web-based enterprise information system.

Multiple Project Tracks (cont.)

- **Innovative Solutions Track**:

3 Months Before	- Solicit potential clients and initiate discussion on requirements. - Consult lecturer on suitability of project. - Prepare project proposal.
Week 1	- Team registration and selection of project track. - Submission of project proposal form.
Week 2	- First consultation with lecturer and confirmation of project. - Switch project track if necessary.

Multiple Project Tracks (cont.)

- **Examples of Innovative Solutions Track projects**:
  - Financial Insurance Enterprise System:
    - Customized information system for an insurance brokerage company affiliated with Great Eastern.
  - Third-Party Logistic Management System:
    - Customized information system to provide integrated management of a third-party logistic company Pan Ocean International Pte. Ltd.
  - Online Event Marketplace:
    - Online B2B2C marketplace for an event management startup – Reneniti Management Pte. Ltd.: Oh My Event!

Multiple Project Tracks (cont.)

- Custom Enterprise Information Systems:
  - Enterprise management system for a one-stop household management service provider startup – Afteryou Pte. Ltd.
  - Enterprise management system for a foot reflexology center – Health Step Foot Reflexology Centre.

  - Engineering and knowledge management system for a SME dealing with metal sheet fabrication – Spark Industrial Engineering Pte. Ltd.

Multiple Project Tracks (cont.)

- **Problems encountered with Integrated Solutions Track projects**:
  - Need to target organizations of appropriate types and sizes:
    - Large corporations may not be willing to let students work on critical information systems.
    - Small businesses' requirements might lack size and scope.
  - Most of the proposed projects are too "simple".
 - Might need to adopt a "system-within-a-system" strategy:

What students needed to get an "A"

What client needed to manage its business operations
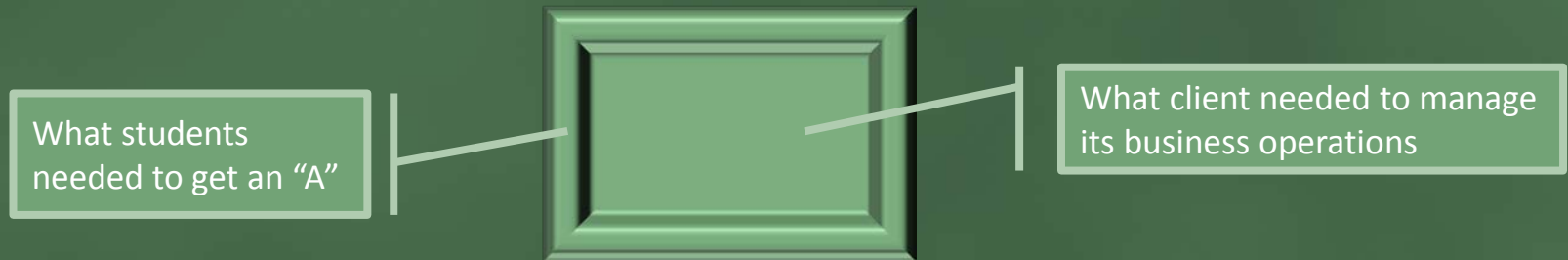
  - Students need to tactfully avoid "requirements or features creep".
  - Subsequent follow-up to complete development work and perform live deployment.
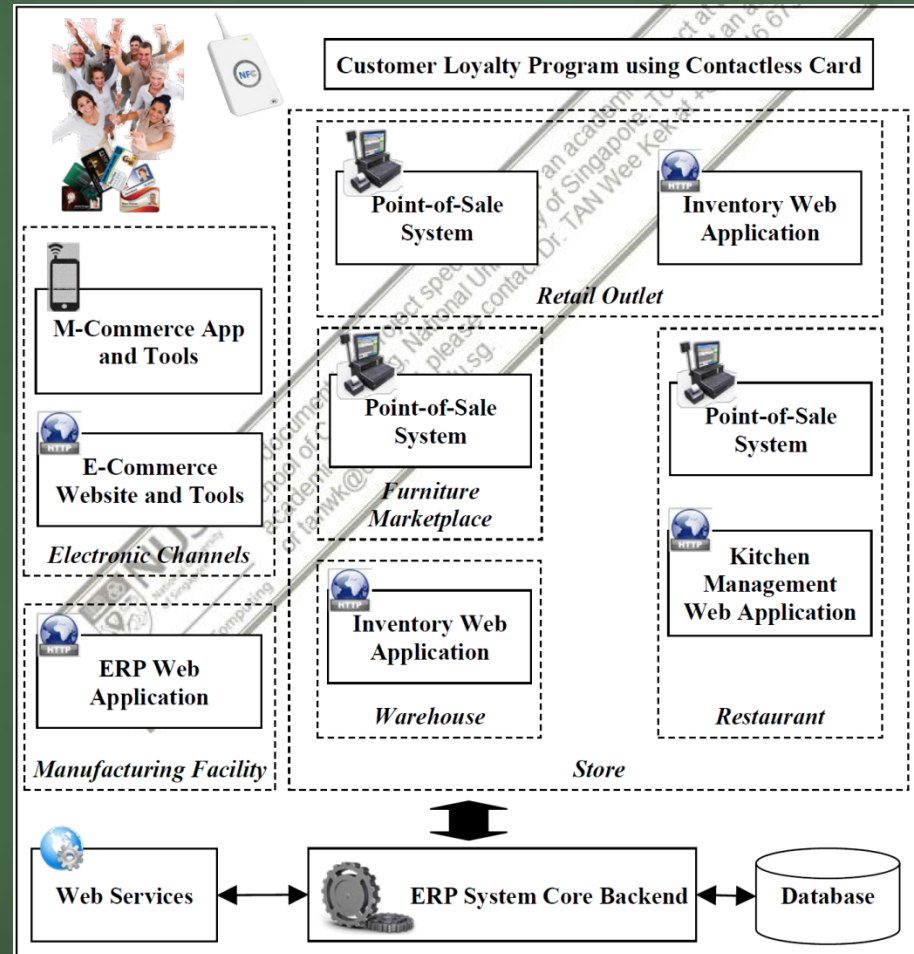
Multiple Project Tracks (cont.)

- **Integrated Solutions Track**:
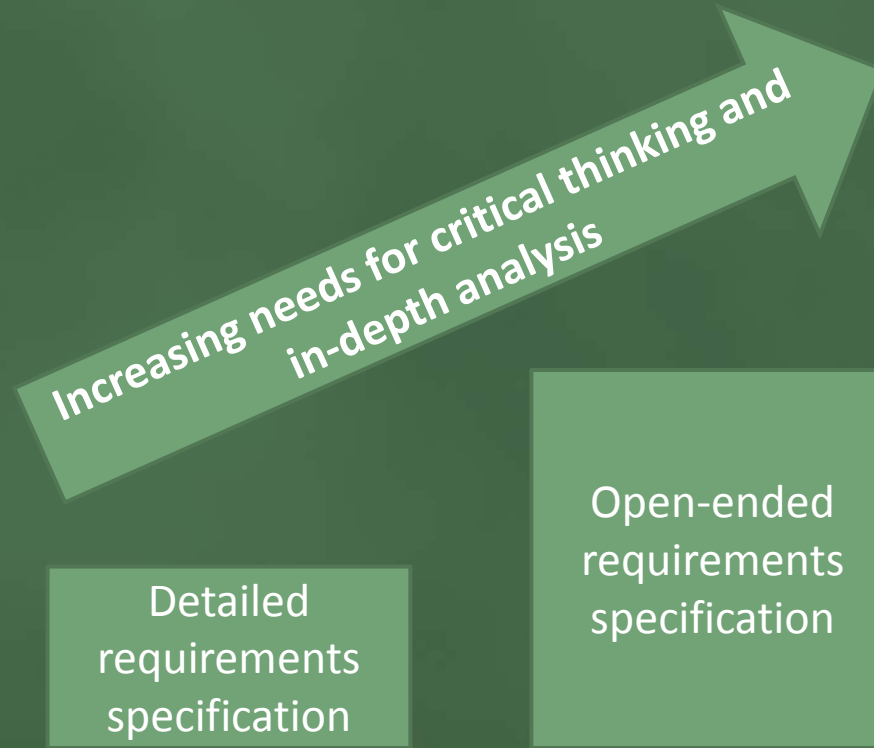   - Integrated Resort Management System (2013):
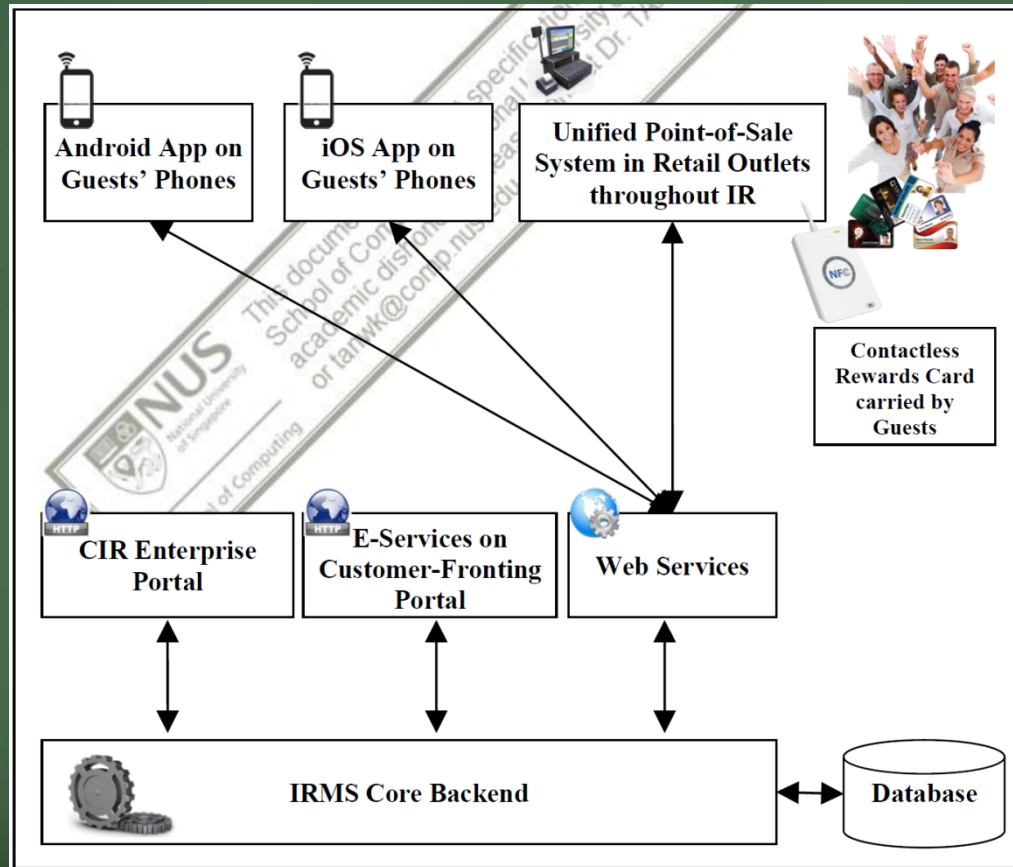
Multiple Project Tracks (cont.)

- Enterprise Resource Planning System for a global furniture manufacturer and retailer:

General Characteristics of Projects

- Departure from "coding project" and focuses on getting students to think and analyze the problem:

Increasing needs for critical thinking and in-depth analysis

Detailed requirements specification

Open-ended requirements specification

General Characteristics of Projects (cont.)

- Greater emphasis on creativity and innovation:

Increasing room for creativity and innovation
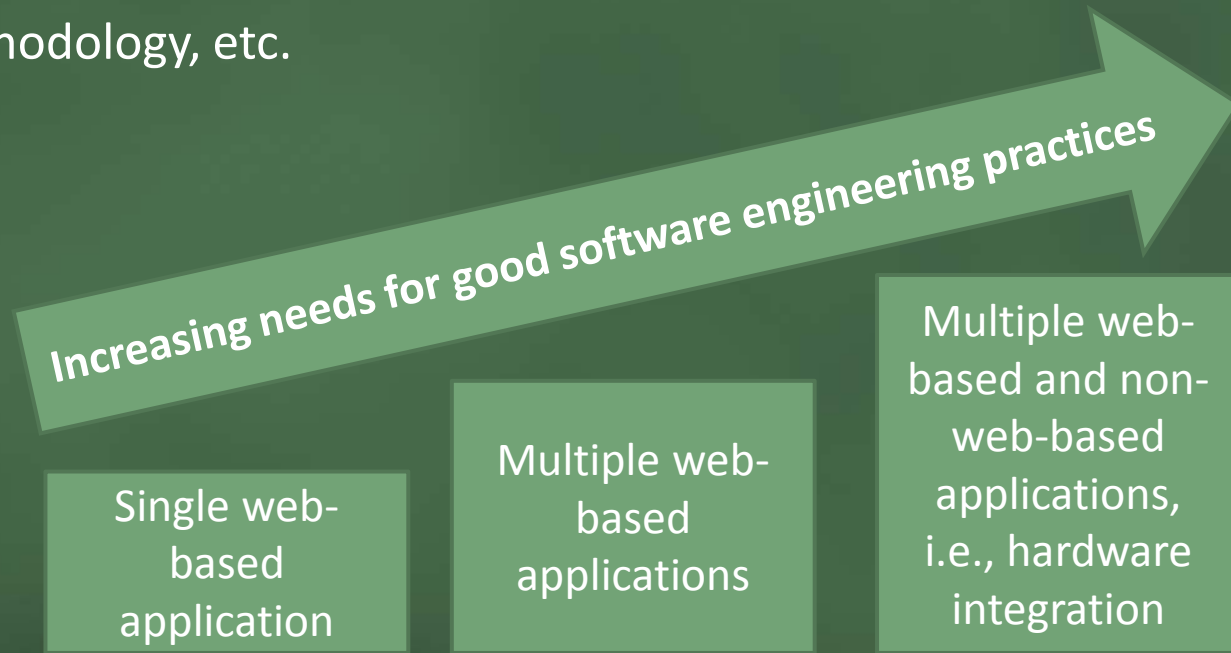
Two parts requirements specification

Business Innovation Module
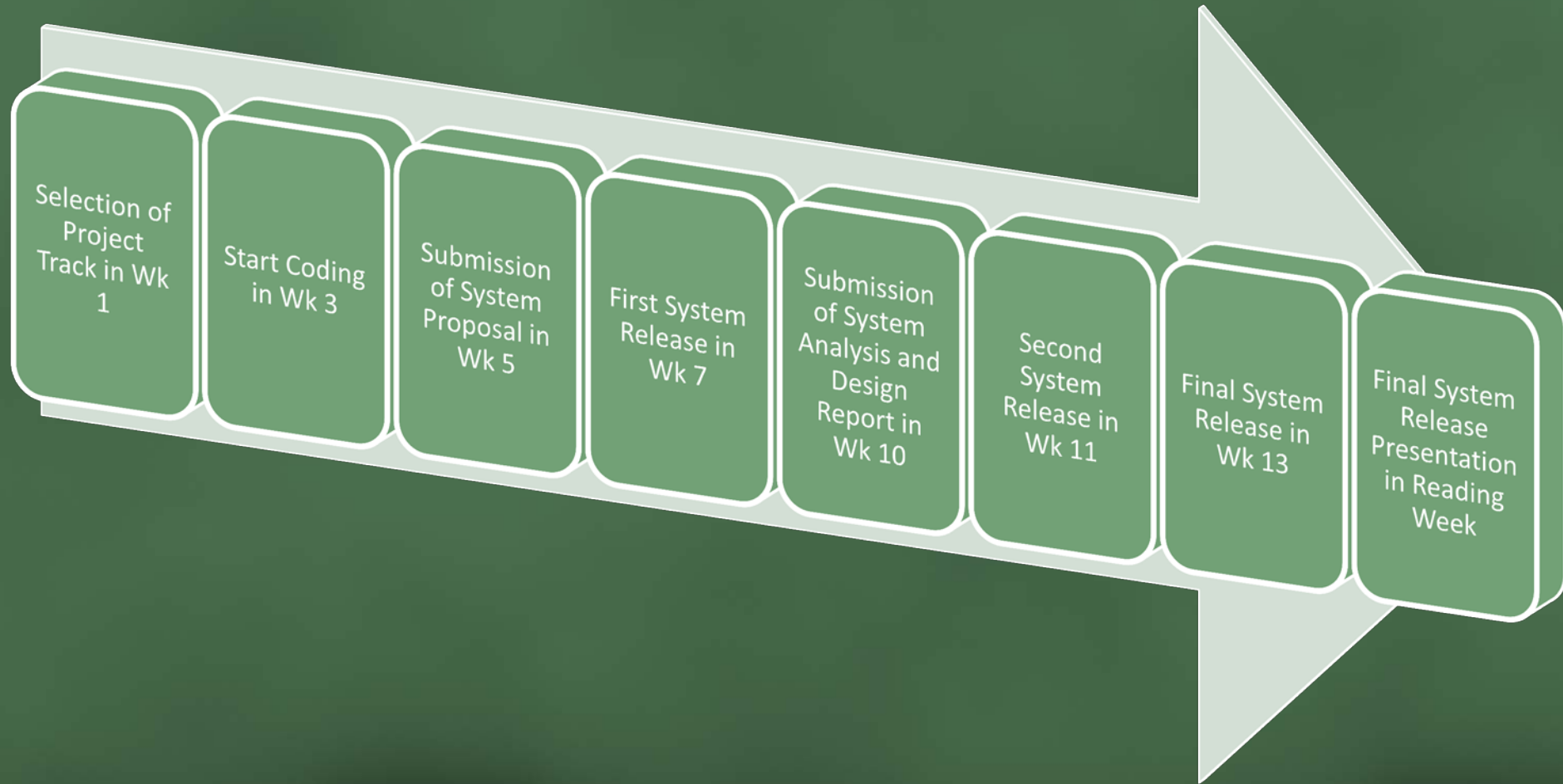
Real-world prescribed project specification

Students self-propose different projects with real-world organizations

General Characteristics of Projects (cont.)

- Greater emphasis on software engineering rigor:
  - Sheer size and complexity of prescribed project specifications forced students to apply good software engineering practices.
  - Object-oriented development, component-based software engineering, service-oriented architecture, test-driven development, agile methodology, etc.
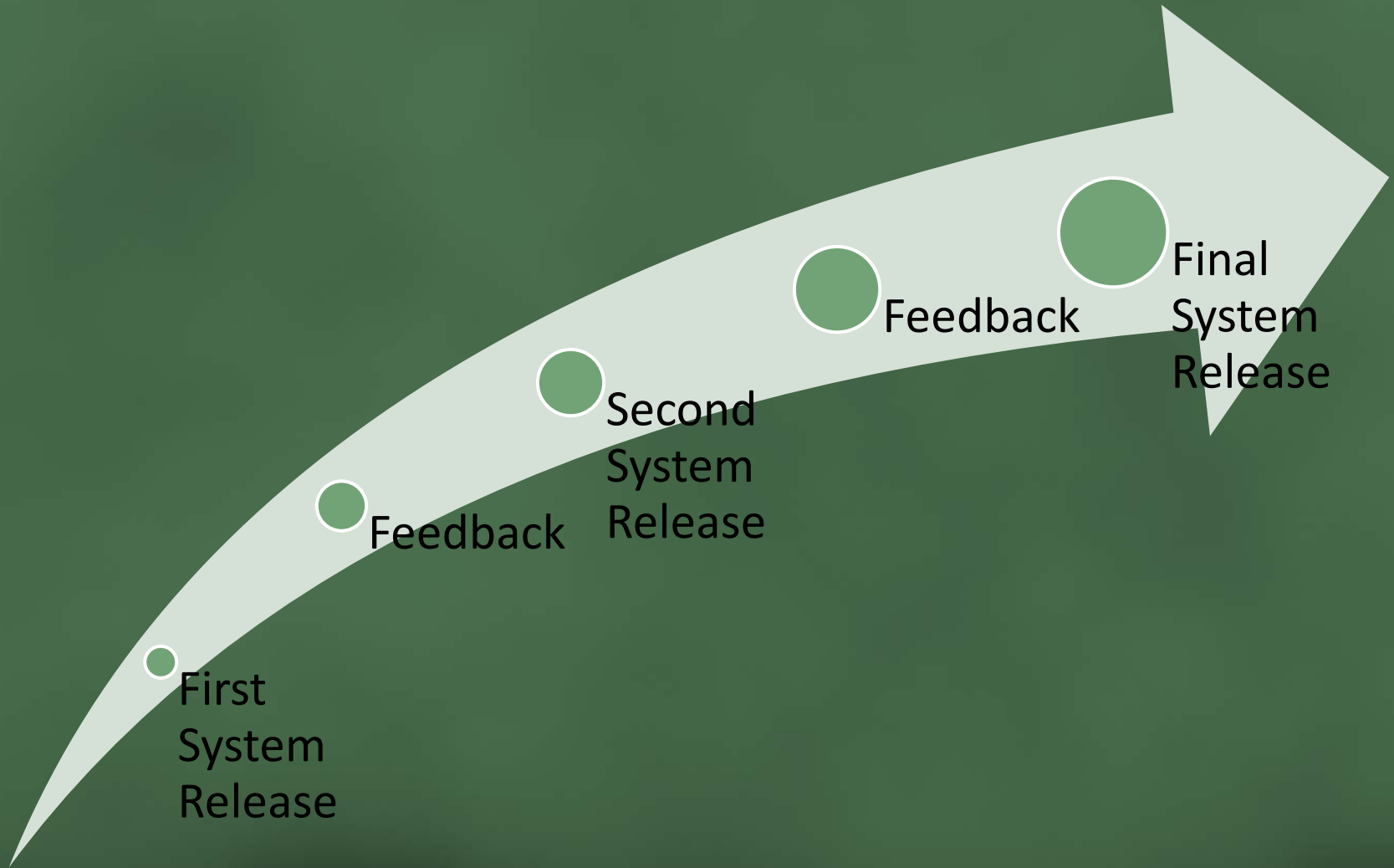
Increasing needs for good software engineering practices

Single web-based application

Multiple web-based applications

Multiple web-based and non-web-based applications, i.e., hardware integration

The IS3102 Process

A process flow arrow containing, in sequence:
Selection of Project Track in Wk 1 → Start Coding in Wk 3 → Submission of System Proposal in Wk 5 → First System Release in Wk 7 → Submission of System Analysis and Design Report in Wk 10 → Second System Release in Wk 11 → Final System Release in Wk 13 → Final System Release Presentation in Reading Week

The IS3102 Process (cont.)

First
System
Release

Feedback

Second
System
Release

Feedback

Final
System
Release

IS Teaching Lab @ ICube

- Designed for team development work.

- Equipped with:

  - Workgroup servers.

  - Point-of-Sale machines.

  - RFID equipment.

  - NFC equipment.

  - GSM modems.

  - Smartphones and tablets.

- New equipment on the drawing board:

  - Bluetooth Low Energy (BLE) beacons such as iBeacon for indoor proximity sensing.

  - Fingerprint scanners.

  - Computerized time recorders.

 - Etc…

The "Final Examination"

- In the past:
  - Students were only required to demonstrate the functionalities "*as is*".
  - Most teams used only one laptop and didn't bring out the flavor of "enterprise" in their enterprise information systems.
  - Presentations done in the Executive Classroom or Video Conferencing Room and difficult to "cross-examine" the students.
- Now:
  - Students are required to enact business scenarios based on the business processes devised in their written report.
  - Students are required to use multiple laptops for the demonstration simulating multiple users with different roles using the enterprise information system.
  - Presentation done in the IS Teaching with the evaluators sitting opposite the candidates in a "round meeting table" fashion.

The "Final Examination" (cont.)
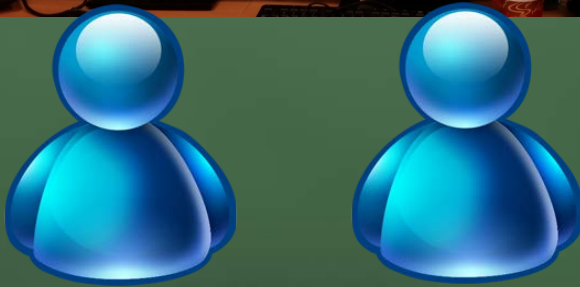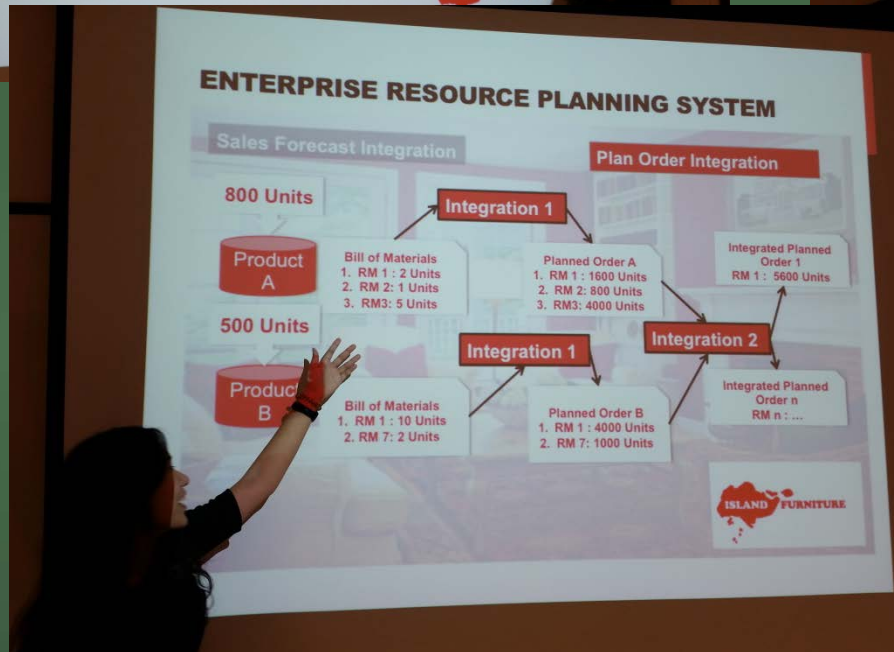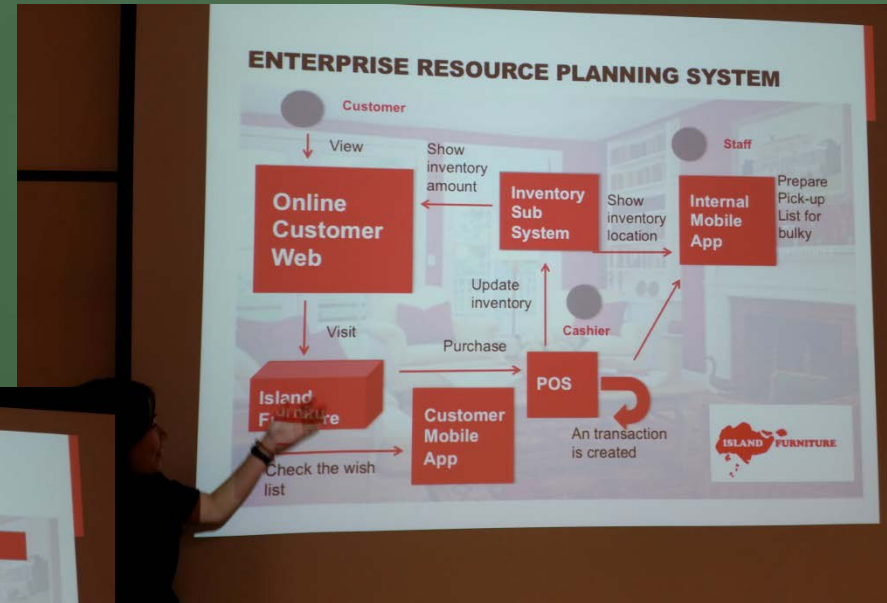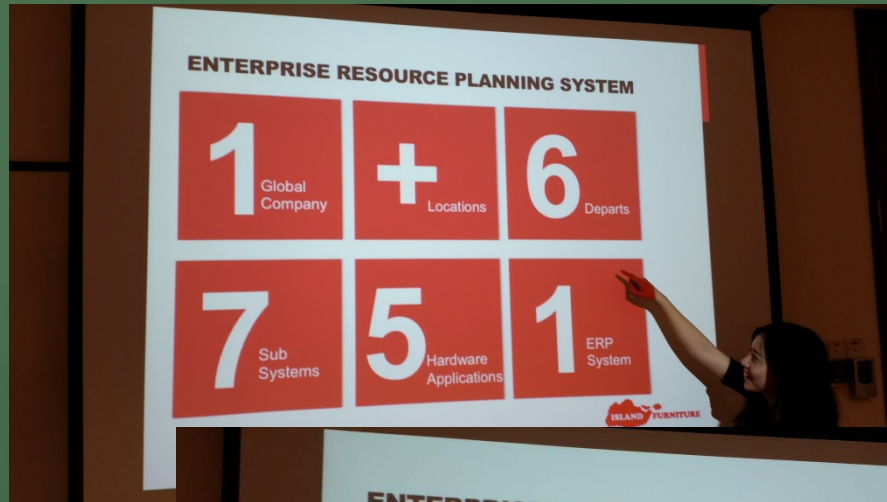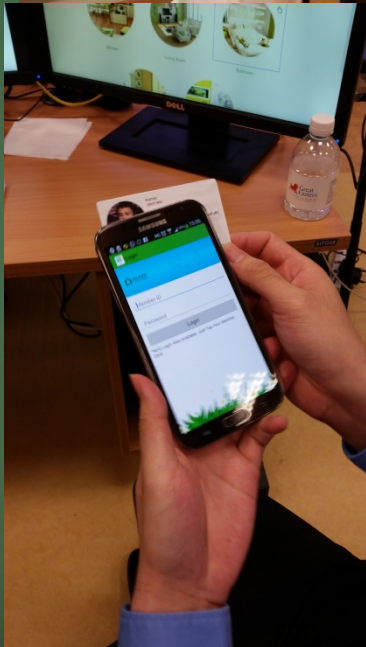
The "Final Examination" (cont.)

The "Final Examination" (cont.)

The "Final Examination" (cont.)

The "Final Examination" (cont.)

The "Final Examination" (cont.)

Summary

- A Perfect IS Capstone Experience for **HIM** and **HER**.
- **H**eterogeneity:
  - Students have different project choices to suit their abilities.
- **I**nnovativeness:
  - Room for creativity and innovation even when working on the prescribed project specifications with open-ended requirements.
  - "100% free play" if students choose the Innovative Solutions Track.
- **M**arketability:
  - In the past, it was difficult to "sell" the capstone project module to students.
  - The introduction of the Integrated and Innovative Solutions Tracks inject greater element of "fun".

Summary (cont.)

- **H**olism:
  - Greater emphasis on balancing business and technical dimensions.
  - Students appreciate how organizational business processes are automated and how to add values to the business at every stage.
- **E**ffectiveness:
  - Greater emphasis on good software engineering practices.
  - Students "automatically" apply them without being told.
- **R**ealism:
  - The entire capstone project experience is as close to the "real thing" as possible – indeed more realistic than internship since IS3102 emphasizes close team work.
  - Use of carefully chosen business domains, incorporation of system integration, and independent engagement with real-world organizations add unprecedented realism to the capstone experience.

Summary (cont.)

- Future long-term plan:
    - Establish a technology transfer center to allow our students to more effectively engage the industry and increase the awareness/profile of our graduates.
    - Possible to work collaboratively with other modules such as:
        - IS4100 – IT Project Management
        - IS4243 – Information Systems Consulting
        - IS4225 – IS Strategic Planning
        - CS3201 & 2 – Software Engineering Project I & II
    - Main hurdle lies with the maintenance of systems post-commissioning.

Thank you for your attention ☺