Development and Delivery of Enterprise Architecture Related In-Class Labs: Current and Future States

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Abstract

Enterprise Architecture (EA) is a relatively new development and looks to create a more holistic view of an organization by taking into account strategy, business and technology. Growing out of the work of John Zachman and Steven Spewak in the 1980s and 1990s, Enterprise Architecture has now become a mainstay in many organizations working in such areas as the aerospace, automotive and banking industries. Enterprise Architecture strives to provide a high-level overview of an organization, while creating a framework around which to organize the documentation necessary to drive adoption and utilization of the EA plan, and to better align technology resources throughout the organization.

This paper describes the development and delivery of in-class labs for the undergrad IS 363 Enterprise Architecture class at St. Cloud State University, a required course in the Information Systems curriculum. The labs were developed over the course of a year and are based on a case study of a fictitious mid-sized manufacturing company that is looking to utilize Enterprise Architecture principles to make it more efficient and productive. The labs encompass both the current state of the enterprise's architecture, and also eventually require the students to produce a future state view that takes into account the business requirements laid forth for them.

The current state labs cover three portions of the enterprise's operations or lines of business: sales, inventory, and production. Due to the fact that the company does not currently have an Enterprise Architecture program in place the current views of the enterprise's lines of business are not optimized and are purposely made to be inefficient and contain redundant processes and manual steps which slows their delivery. The students are then given a Microsoft Visio diagram utilizing the Unified Modeling Language (UML),

along with a description of the current steps necessary to perform the various business requirements. They are then required to answer questions related to the current state, including what steps are inefficient or outdated, what types of IT systems or technology could improve the process, and possible suggestions for business process redesign.

Once the students have covered the current state views they are then given a new business requirement, namely the creation of an integrated future state of the processes. The students are then required to create a future state view of the enterprise, while utilizing the open source Archi EA modeling tool or Microsoft Visio to provide an integrated view of the architecture that covers the previously described three lines of business. It is hoped that these hands-on labs will ground the students in the need for EA and how it can provide value to complex organizations that are constantly needing to adapt to changing business and technological environments.

Key words: Archi EA Modeling Tool, EA^3 Framework, Enterprise Architecture, Unified Modeling Language (UML), Visio

1 Introduction

This project has developed out of a lack of quality Enterprise Architecture (EA) teaching resources for the post-secondary market. While at the same time EA has become a required topic that is required to be covered by the IS 2010 standard of curriculum (ACM & AIS, 2010) there are limited teaching resources that are available to effectively cover this emerging field in information technology (IT). Although this topic has become a recommended requirement for information systems (IS) majors in colleges and universities that follow the IS 2010 standard promulgated by the ACM and AIS (2010) there are no commercially available textbooks covering EA. There are valuable practitioner resources available in the marketplace, see (Ross, Weill, & Robertson, 2006) as well as (Bernard, 2012), though they are not in any sense a typical academic textbook in the common sense. While these resources are useful in covering the basic concepts and historical development of the field of EA, they lack much of the in-class resources that many contemporary IT related textbooks provide, such as PowerPoint slides, test bank questions, and most importantly in-class exercises that effectively cover the concepts of EA.

Thus, there is a relevant need for quality teaching aids in the area of EA for undergraduate programs to effectively display the concepts covered by EA and allow students to have a hands-on resource to apply the concepts that are covered in the available text resources in the classroom. In many respects EA is a high level meta-discipline concept that can be difficult to properly present to undergraduate IS students who often have little to no real-world experience with complex legacy information systems that were developed in an era where strategic IT planning often did not exist, which lead to disparate IT silos of computing capabilities. These computing silos have plagued enterprises since the dawn of computing in the 1950s and 1960s and were driven by proprietary systems and applications that offered little or no interconnectivity with other vendors systems and applications (Mirowski, 2017). Conveying these concepts can be extremely difficult, especially to

students who have grown up in an age of client/server computing with easily interconnected devices through shared web services. Thus, there is a need for easily consumable labs to convey these high-level problems that exist in complex organizations.

The goal then of this project, and the aim of this paper, is to produce EA related in-class labs that will allow students to apply the concepts that are covered in the class lectures and apply it to a fictitious company which exhibits many of the real-world problems seen by companies of all sizes. The Bernard book (2012) is used as the primary text in the IS 363 Enterprise Architecture class and thus the labs have been tailored to it, including basing the situational data on the operations of a fictitious mid-sized manufacturing company called Danforth Manufacturing Company (DMC) which is offered by Bernard (2012) as an ongoing example of how EA concepts can be utilized in various business and technology related decisions. The first three labs cover the current architectural views of DMC and students are then asked to identify areas of inefficiency in the technology and business processes that are displayed. And then they need to take the information and design a optimized future view of DMC. The labs are constructed using the Microsoft Visio application and take advantage of the Unified Modeling Language (UML) to graphically describe the flow of processes within the DMC enterprise (UML, 2018).

2 Review of Literature

The development of EA as a practice has taken place over the course of at least the last 30 years, though some feel the earlier concepts of business systems planning (BSP) which started in the late 1960s and was created by IBM are the true precursor to EA (Kotusev, 2016). BSP was meant as a way for organizations to collect data on the organization by interviewing members of an organization and then developing a top-down plan while describing the information system plans by looking at the relationship between the organization's structure, business processes, the information systems, and the data housed therein (Kotusev, 2016). As Bernard (2012) mentions the coalescence of these earlier design methods began to culminate in the concept of Enterprise Architecture in the late 1980s with the Zachman Framework in 1987, however Kotusev (2016) claims that an even earlier example, the PRISM EA Framework was introduced in 1986. Either way the concepts around EA, namely the documenting and developing of an organization's information technology infrastructure and systems so as to eliminate duplication and redundancy, had been slowly maturing through at least the 1970s and into the 1980s.

The first EA methodology where the terms enterprise and architecture appeared was proposed by Steven Spewak in 1992 and was called Enterprise Architecture Planning (EAP), this was loosely based on the BSP created by IBM more than a decade earlier (Spewak & Hill, 1992). The EAP was looking to build on the work created by Zachman by building on an additional top two layers onto the Zachman model, while following five steps to create an effective EA practice that could be utilized by organizations of all sizes. The steps were: first, research and document the current state of the organization; second, create the intended future state that the organization is striving to reach; third, determine the gaps between the current and future states; fourth, develop an implementation plan that will guide the transition from current to future state; and fifth, implement the plan that was developed (Spewak & Hill, 1992). Many of the modern EA frameworks roughly follow

these steps, including the EA^3 Framework that was developed by Scott Bernard (2012) and is covered in-depth in the text used for the IS 363 Enterprise Architecture class, "An Introduction to Enterprise Architecture".

The adoption of the Clinger-Cohen Act in 1996 by the United States Congress effectively brought the adoption of EA into the mainstream, as the Act required all Federal government agencies to adopt some type of EA framework that was compatible with the National Institute of Standards and Technology (NIST) EA model (Kotusev, 2016). From this requirement the creation of the Federal Enterprise Architecture (FEA) was created along with the FEA Framework which was based on the EAP and aligned with the requirements set forth in the NIST EA model, and many of the Federal agencies adopted the FEAF or similar frameworks for the IT operations and planning decisions (Kotusev, 2016). The Department of Defense was one of the earliest adopters of EA amongst Federal agencies and created its own framework in 1994 which was called the Technical Architecture Framework for Information Management (TAFIM), the various steps in the TAFIM Framework can be seen in Figure 1 below.

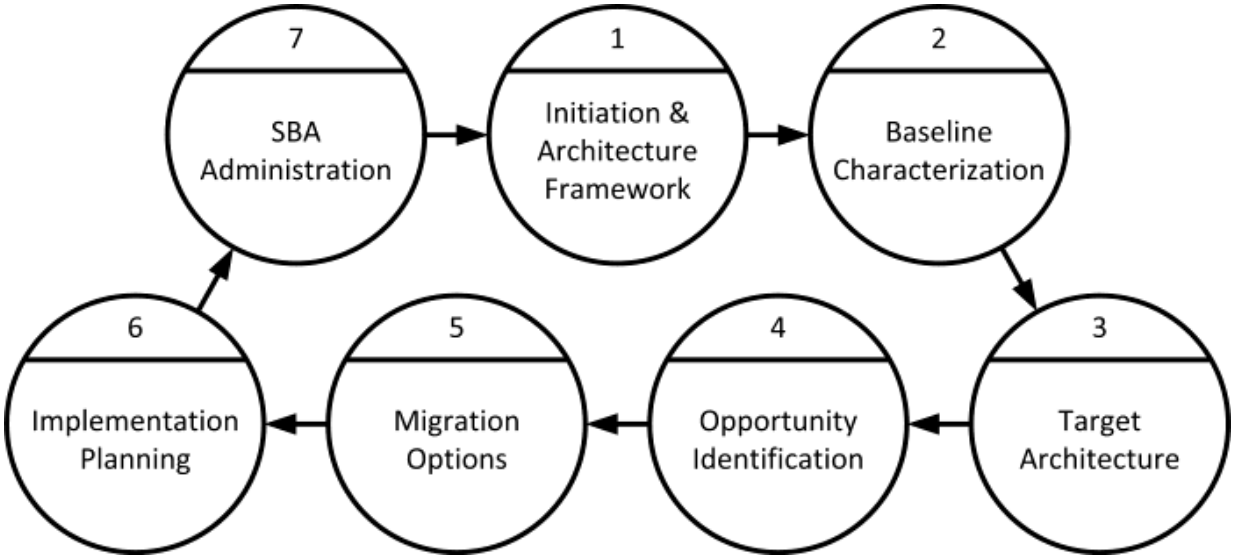


Figure 1: TAFIM Methodology (Kotusev, 2016).

The TAFIM Framework was then superseded by the development of other frameworks and ultimately lead to the creation and adoption of the Department of Defense Architecture Framework (DoDAF), which has gone through multiple iterations (Bernard, 2012). The work around TAFIM was not lost however, as the work and related documentation was handed over to a newly formed non-profit organization, The Open Group which continued the development of the work under the new The Open Group Framework or TOGAF (Bernard, 2012). TOGAF has become the most commonly used EA framework among organizations throughout the world, and the current iteration TOGAF Version 9.1 has gone through a great deal of change from its early beginnings growing out of TAFIM. TOGAF

is commonly cited as the most often adopted EA framework currently in use, and in many ways has become the de facto standard for most public and private companies (Kotusev, 2016), and has even been adopted by some Federal agencies (Bernard, 2012). As can be seen below in Figure 2, the TOGAF Capability Framework, which encompasses various parts of the overall TOGAF framework is far more complex than its humble beginnings as TAFIM (TOGAF, 2018). Although the level of complexity and the number of frameworks has greatly expanded, most of the newly designed EA frameworks all take their core elements from the earlier works of Spewak and Hill (Kotusev, 2016). The value provided to organizations by EA is typically seen through readily available documentation, reduction of redundancy of computing resources, and better sharing of data across the organization (Brown, 2004).

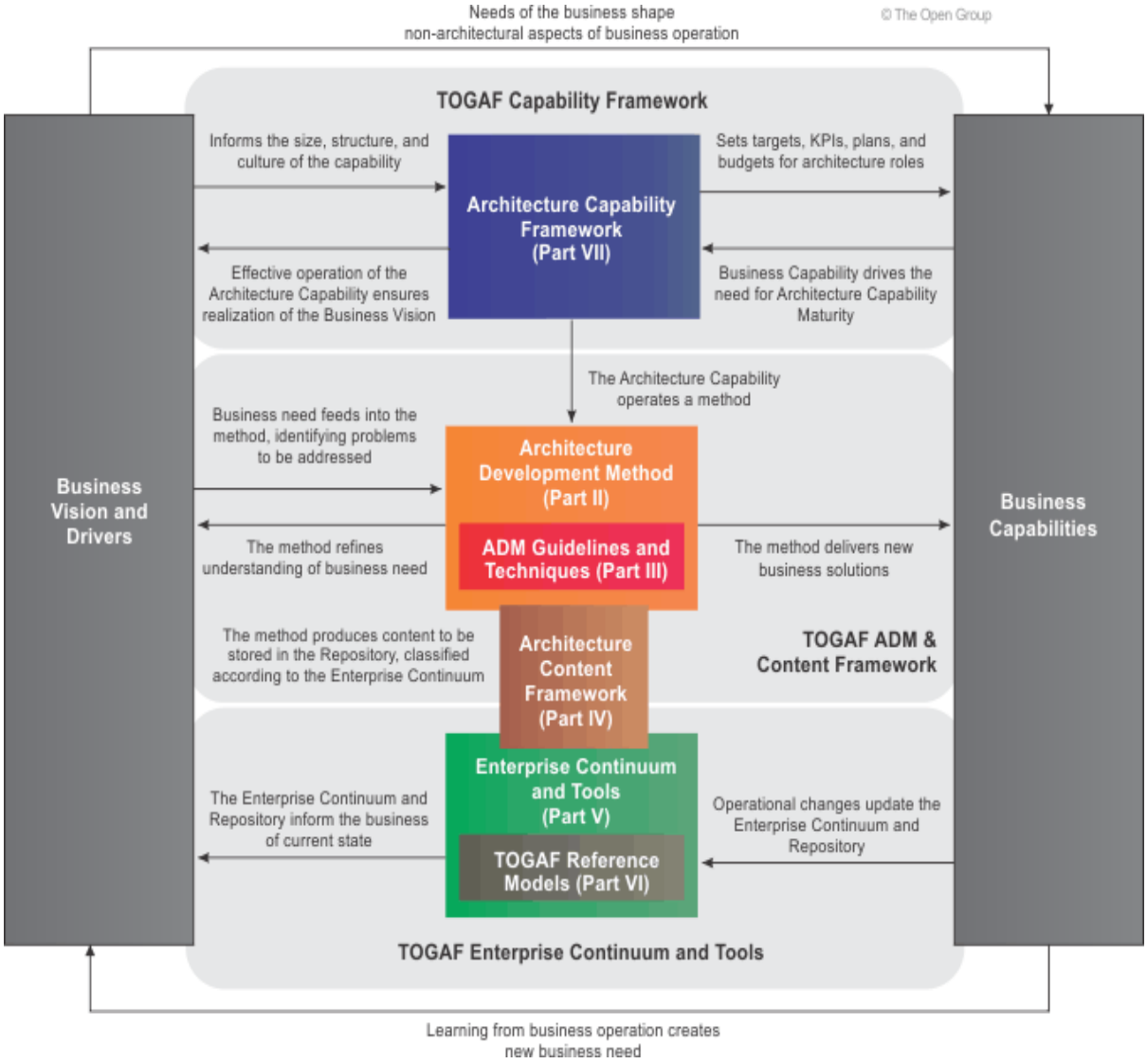


Figure 2: TOGAF Capability Framework (TOGAF, 2018).

Organizations that are able to effectively utilize EA will often times provide pragmatic artifacts or documentation covering such things as strategic requirements, specifications,

principles, and models that will lead the organization into the optimized future state that was described by Steven Spewak and others (FEAPO, 2013). As a major side benefit to the documentation efforts required by EA it will often aid in mergers and acquisition efforts, as the organizations that are coming together will have a far greater understanding of the current state of their technology infrastructure (Bernard, 2012). For these reasons, many organizations now view the adoption of some type of EA framework as a necessity and not an optional exercise, and therefore the teaching of EA related concepts is crucial to undergraduate information systems and other technology related majors who will be exposed to these concepts in the workplace. Thus, the need for effective teaching tools to present the various concepts covered in EA and provide students with hands-on labs that will allow them to apply the concepts covered in works such as Bernard (2012) and Ross, Weill and Robertson (2006).

3 Methodology

3.1 DMC Organization Background

As was previously mentioned there are very few resources available on EA which are dedicated strictly to higher educational instruction, although Bernard (2012) offers quality background on the history and concepts of EA, it lacks the instructional materials often found with many textbooks. Therefore, the need to create viable instructional resources that can be used in the classroom to illustrate the concepts that are covered in what are primarily practitioner-based books or articles (Nowalkowski, et al., 2017). Hopefully the creation of hands-on labs based on the case study of a fictitious manufacturing company, DMC (Bernard, 2012) will allow students to apply the concepts around EA to real-world situations, taking into account the higher up levels on Bloom's Taxonomy into the analysis, synthesis, and evaluation levels (Bloom's Taxonomy, 2018).

In creating the labs, the first step was identifying the current state of DMC's architecture and its needs, in the case study presented in Bernard (2012) a scenario is offered where a decision around whether to develop an in-house inventory tracking system called SITS or purchase an off the shelf enterprise resource planning module by a fictitious company called WELLCO should be used. In the IS 363 EA class students need to perform a business case analysis on this decision, however it does not require them to do any modeling of systems or business processes, thus additional labs to cover these core concepts were required.

3.2 DMC Current State Labs

To better understand the steps of documenting and describing the current state of an enterprise's architecture, three labs were developed to look at three specific areas of DMC's business its sales, inventory, and production processes. These areas are purposely designed in an inefficient manner so as to allow students to assess the potential issues that could arise with poorly designed business processes and outdated technologies. As can be seen in Figure 3 below the current DMC sales process has many design inefficiencies, including the fact that manual querying of databases needs to take place to provide sales staff with answers on pricing as well as the process needs to be handled manually by

accounting department staff as well as by people in the inventory department who need to manually determine if the materials necessary to assemble or manufacture the finished products, in this instance various solar powered battery systems, are available (Bernard, 2012).

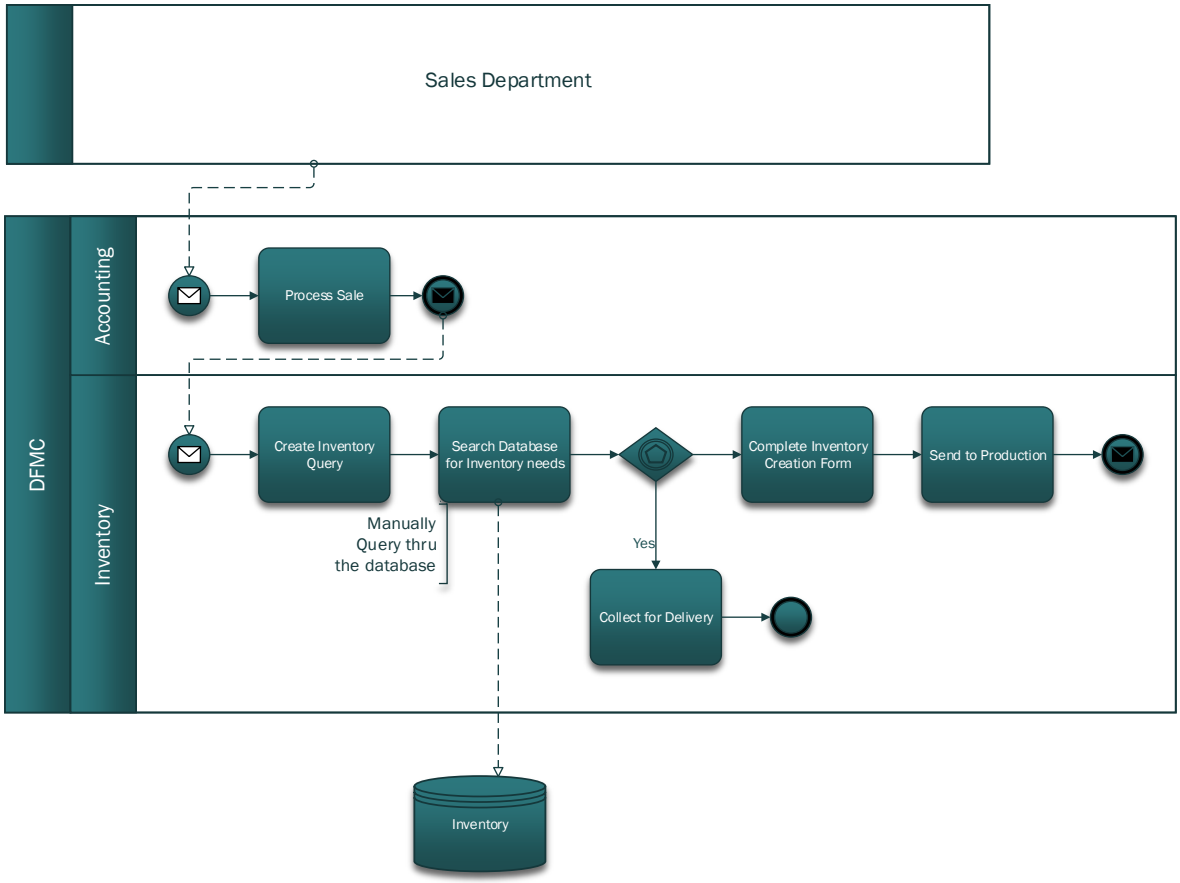


Figure 3: DMC Current State - Sales Process

In Figure 4 below the current state of the DMC inventory process is shown. Again, the current state is designed in a way that redundancies or poorly designed processes are apparent so that students can analyze and identify them as well as propose changes that would make them more streamlined and efficient. Including the querying of multiple databases for various parts of the process, in which these steps are manually performed by workers who have to input the information at each step of the process. Many of these steps could be made more efficient, and ultimately this will provide the template for which students to attempt to design a more efficient process in the future state view. Also, the development of a data warehouse structure where data throughout the organization can be coalesced and updated through extract, transact, and load (ETL) processes would also make the transactional processes more efficient.

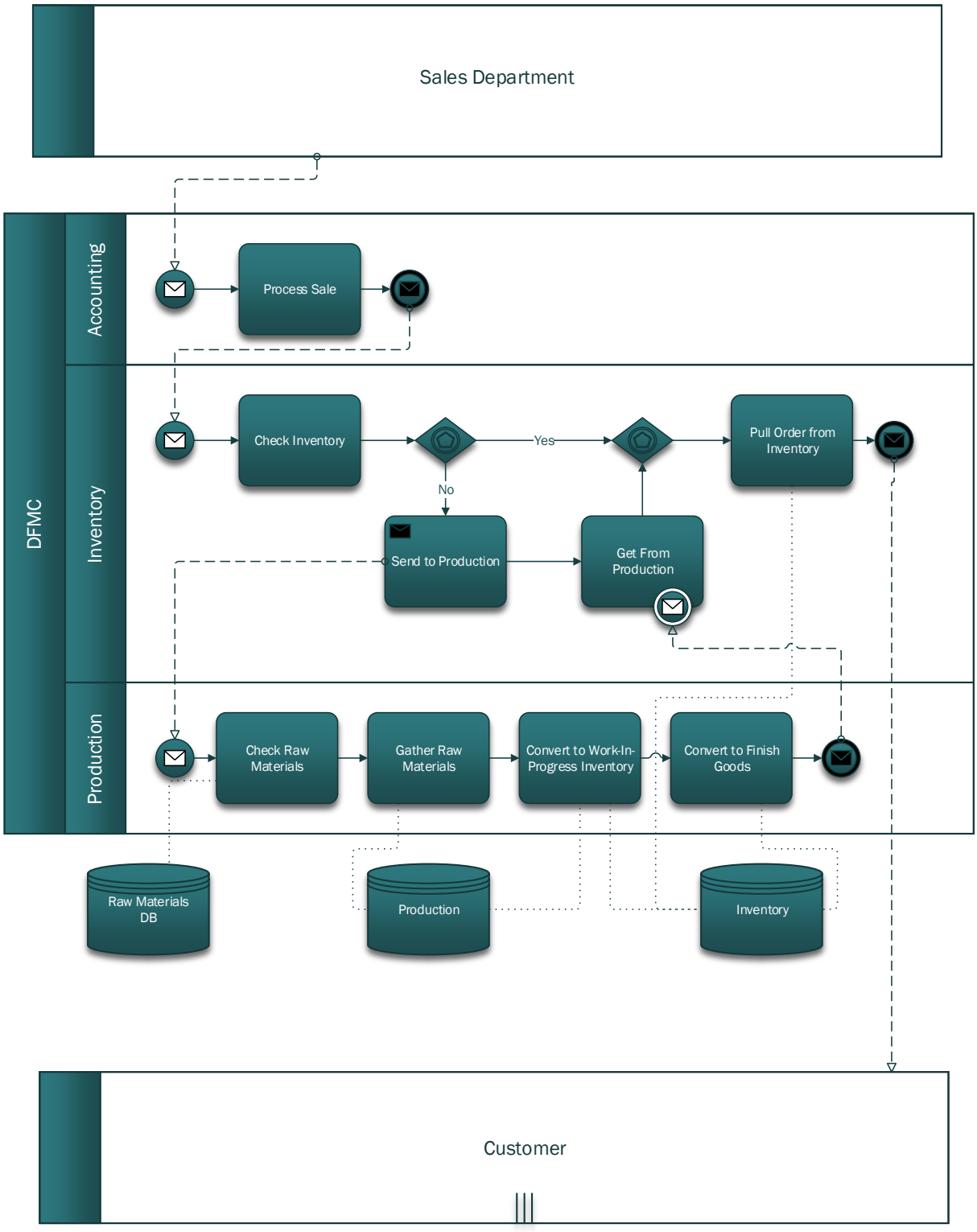


Figure 4: DMC Current State - Inventory Process

In Figure 5 below can be seen the current state view of the DMC's production process, basically after an order has been received and gone through the inefficient sales and inventory process it will then enter into the final stage of product assembly. Again, the process has inherent inefficiencies built into it, so that students can find and describe ways in which the process can be changed to provide a more efficient working model. Such as the requirement to manually go thru the database to determine if the production materials are currently available and whether the production schedule will allow for the timely delivery of the ordered products given the sales quote and inventory considerations previously covered in the other two current state processes. Note that the "Complete Production" step within the process has been blown up below the flow chart so that sub-processes can be more accurately described, see Figure 5.

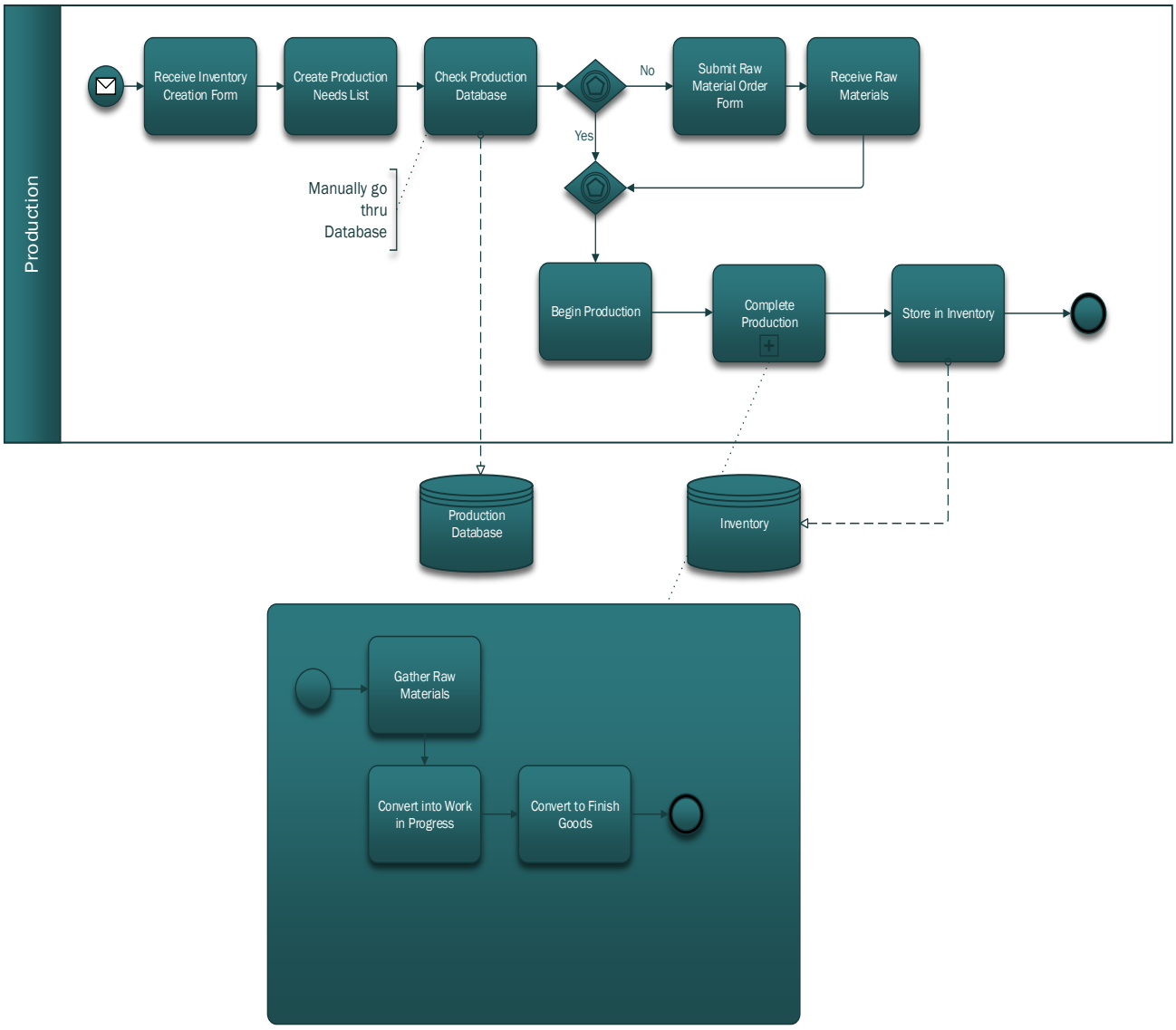


Figure 5: DMC Current State – Production Process

3.3 DMC Future State Labs

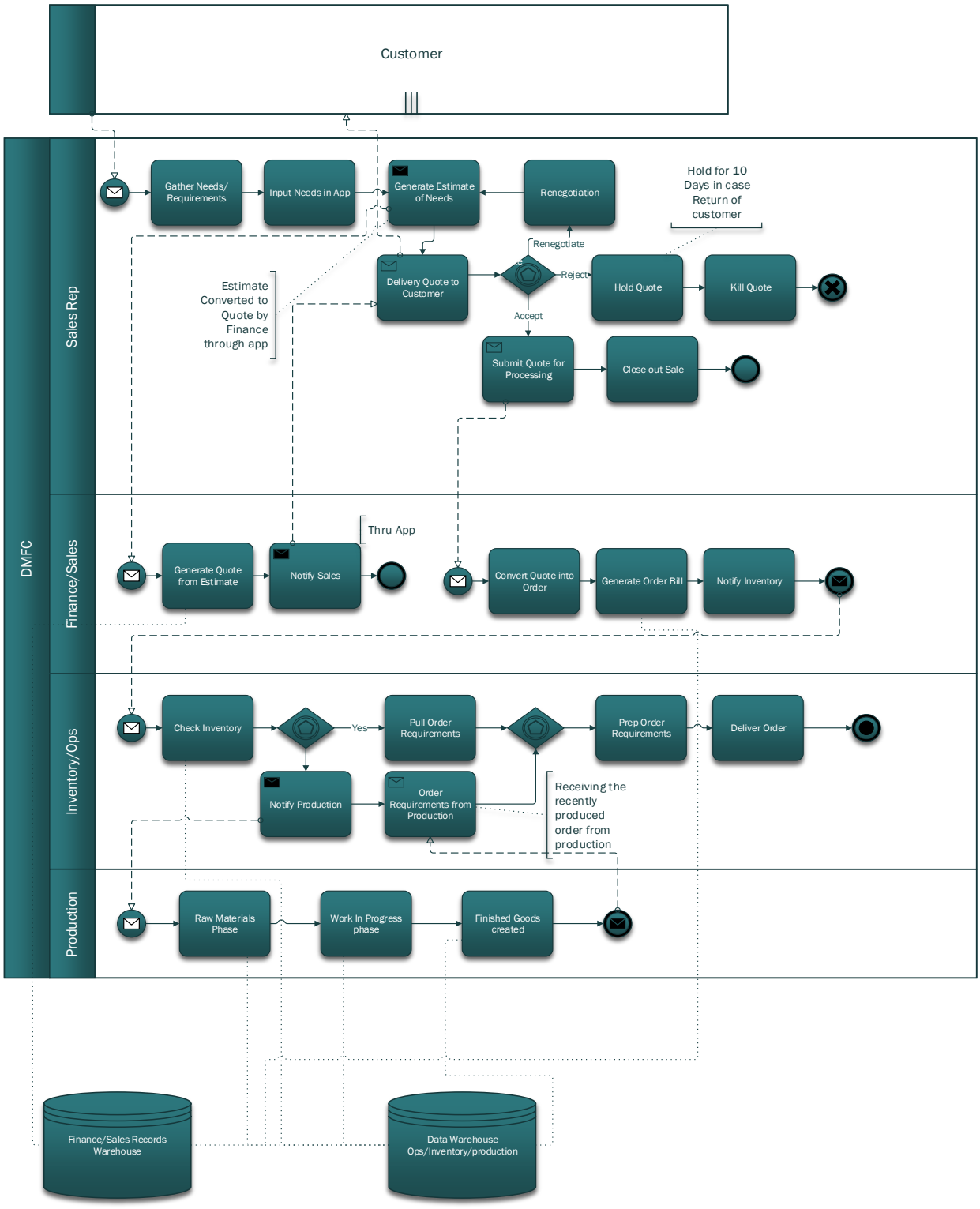


Figure 6: DMC Future State – Integrated Sales, Inventory, and Production Processes

Figure 6 above shows the authors' conception of an integrated future state of the DMC sales, inventory and production processes. Effectively the newly designed systems and processes such as for the sales process with automated financial quotes versus manually generated quotes by accounting personnel, the automatic delivery of finalized quotes to customers, as well as holding and eventually terminating quotes. For the inventory process many of the steps which were required to be performed manually by staff are automated and fully integrated with both the financial/sales process which precedes it and also the post production process which follows it. In the production phase we can also see the use of automation as well as the concurrent flow of processes so that things do not need to proceed in a fully serial or sequential mode, but processes can automatically proceed concurrently if possible to save time and effort to have more prompt delivery of finished products to DMC's customers.

4 Implementation

The creation of these current and future states of the fictitious DMC required utilizing the fairly minimal content provided about the company in Bernard (2012) and extrapolating from it to craft a rational current state of the architecture which is not optimized, both to hold true to the context created by Bernard as well as to allow for students to find and fix potential issues they identify and then craft a more efficient future state. To do this the authors had to craft a narrative based on the context provided and through whiteboard brainstorming sessions, see Figure 7 below, and build believable but yet flawed current state views which could then be fixed by the students who would be reviewing them.

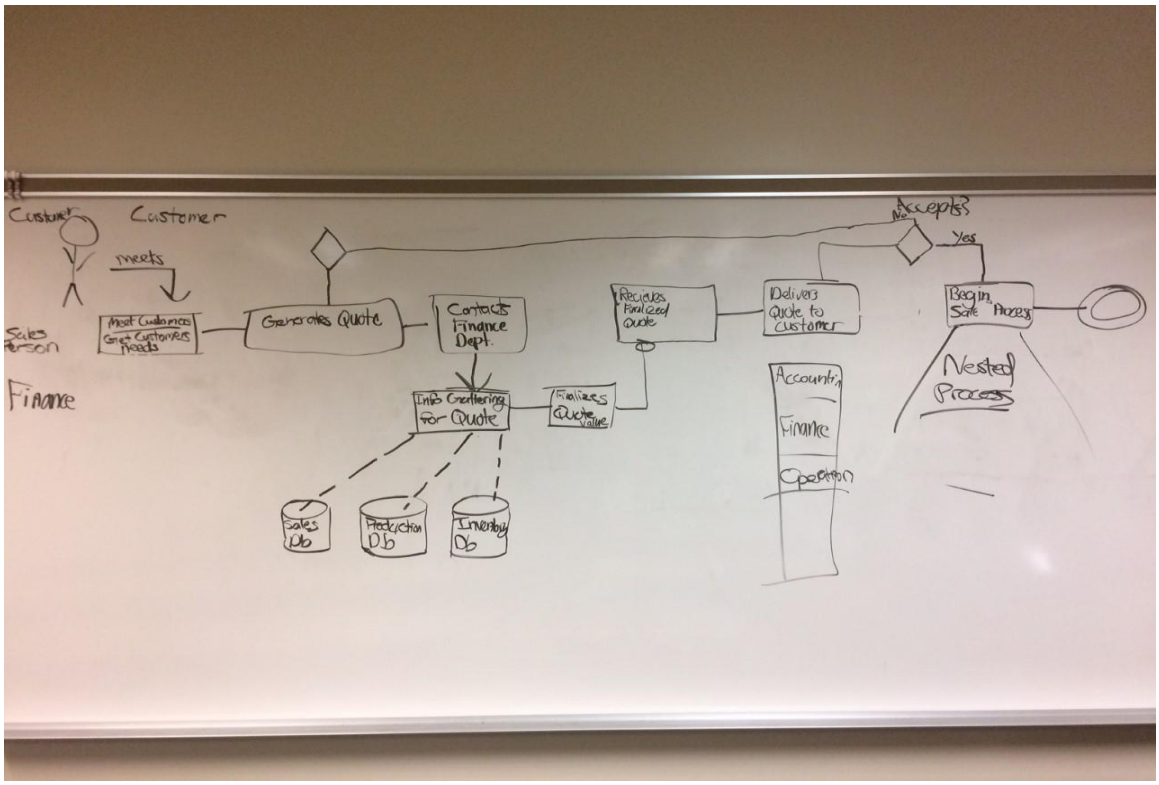


Figure 7: Whiteboard Session – DMC Sales Process

From the whiteboard sessions the development of the current and future state views were then created using the Microsoft Visio application, which is very effective at mapping and developing complex business process flows using UML (Visio, 2018). The initial beta version of an in-class lab was designed and delivered during the 2017 fall semester to the IS 363 class, this can be seen in Figure 9 below and covers the DMC sales quoting process. The feedback of the lab and responses to the three questions that were asked of the students were recorded and then taken into consideration for future development of the in-class labs.

The current development of the in-class labs is that the three current state views described in Figures 3, 4, and 5 will be used for the in-class labs, these will then be delivered to small groups of 5 to 6 students to look over, discuss, and then point out the potential flaws and inefficiencies in the designs. Once they have gone through the three current state exercises the next step will then be to provide them with the future state lab in which they are given the task in their small groups to take the recommendations they have come up with in the previous exercises and create their conceptualization of a more efficient future state. The future state which the authors created in Figure 6 is not definitive, instead it is merely a possible rational view which could be created, thus it is to be used not as an official "rubric" or "key" that they should match but more as a guide which has perceived efficiencies and more optimized processes.

The next step would be the demonstration of the Archi EA modeling tool, an open source software application that can be run on multiple operating systems and is useful for modeling EA and business processes, as seen in Figure 8 (Archi, 2018).

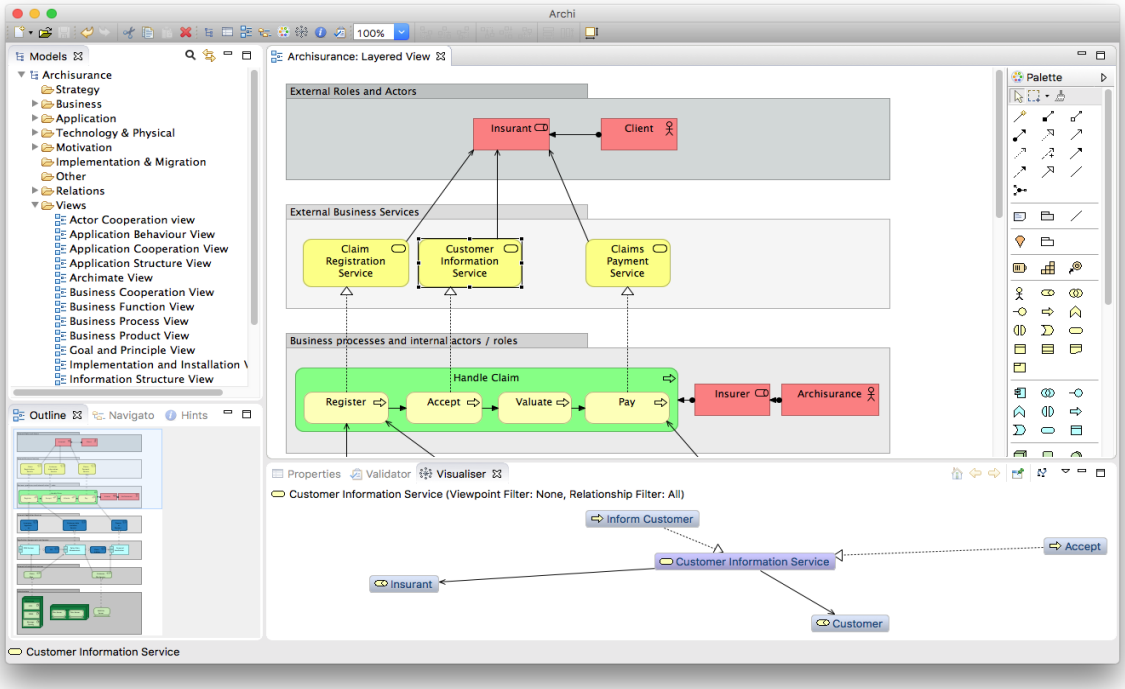
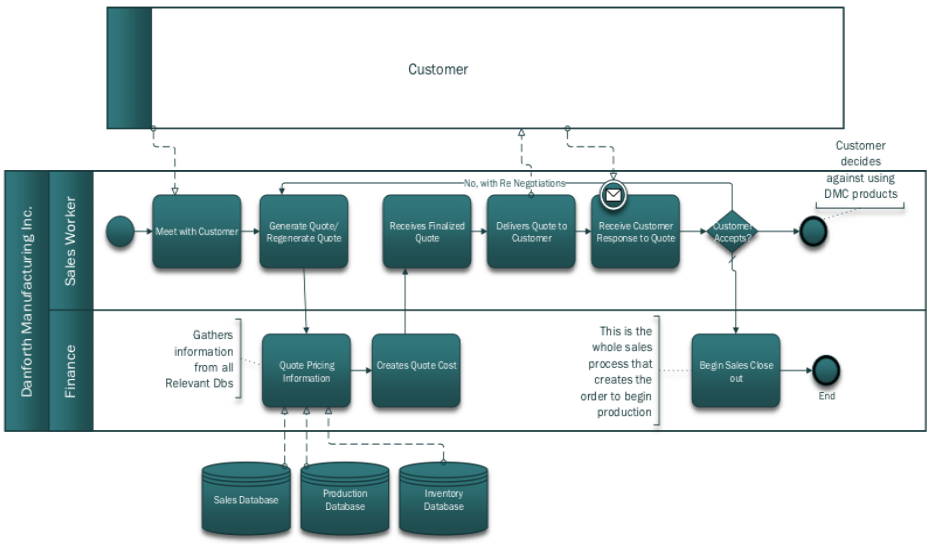


Figure 8: Archi EA Modeling Tool

The labs which were created by the authors were done using the Microsoft Visio application, the Archi Tool is also used as it is designed specifically for EA modeling and as an open source software application it is free to download and use, unlike the Visio application. Archi is also designed for optimization with the Archimate language which is the modeling language used by the TOGAF EA framework (TOGAF, 2018). However, the students do have access to both applications so either of them, Archi or Visio, can be used to perform the future state lab where the small groups are asked to create their version of a future state of the DMC architecture that is more optimized and efficient. The students will then have to justify the choices they made and explain why they decided on the changes to the systems and processes they made. Finally, the groups will give a short in-class presentation describing their conceptualization of DMC's optimal future state and compare and contrast their architectural view with the version created by the authors.



This is the current view of the Danforth Manufacturing Company's sales quoting process. Salespersons will typically engage a customer and over the course of two or three days determine the customer's requirements and what DMC products would meet their needs. After the salesperson determines the necessary products, they send the list to the Finance department by way of fax or email, the Finance department then determines the pricing for the products. This process typically can take one to two weeks depending on how busy Finance is, or if the order is highly specialized, it could take even longer. Once the quote is created, it is sent back to the salesperson who delivers it to the customer by way of fax, unless they require a signed hard copy which would be sent by certified mail.

Once the customer receives the quote they have five business days to either accept, reject, or renegotiate the terms. If they renegotiate the process repeats itself, if they reject and move on to another supplier the sales quote process is terminated, and if they accept the quote moves forward to bill of sale creation and sent to the Accounting department.

In your Groups, answer the following three questions:

1. What do you think is wrong or outdated with the current process?
2. What IT systems or technology could improve this process? And Why?
3. Possible suggestions for redesign of the business process, **please be specific.**

Figure 9: Example of DMC Current State Lab – Beta Version

5 Conclusion

In conclusion, the development of these in-class labs has been an ongoing exercise over the course of the past year between the authors, a former student in the IS 363 Enterprise Architecture course and the instructor. This collaboration has been very useful as both the teacher and student perspective have been taken into account throughout the entire process to design and deliver the labs. The ultimate goal is to provide students with hands-on examples to use and apply the concepts that they have learned through the course of the class, and also to use valuable modeling tools such as Archi and Visio which will undoubtedly provide valuable experience once the information systems students enter the workforce. Continued development and refinement of the labs will continue, with the full rollout of the three current state labs occurring this spring 2018 semester along with the future state lab and group discussion. From these results additional refinement and development of the labs will proceed over the course of the summer, with the additional goal of having the finalized current and future state labs available for the fall 2018 semester, and also the integration of the labs into a fully online offering of IS 363 which will also be offered this fall. This will require the use of collaboration tools such as Skype for Business or Adobe Connect to complete the group projects, as well as the needed feedback from the instructor.

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