

MODEL-DRIVEN DESIGN: SYSTEMATICALLY BUILDING INTEGRATED BLENDED LEARNING EXPERIENCES

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ABSTRACT

Developing and delivering curricula that are integrated and that use blended learning techniques requires a highly orchestrated design.

While institutions have demonstrated the ability to design complex curricula on an ad-hoc basis, these projects are generally successful at a great human and capital cost.

Model-driven design provides a sustainable approach that reduces some of the cost of complex curriculum development and improves the sustainability of curriculum innovation.

Systems thinking is a perspective for going beyond events, to looking for patterns of behavior, and to seeking underlying systemic interrelationships which are responsible for the patterns of behavior and the events.

Model-driven design provides the ability to share models and learning units beyond the borders of the institution.

I. INTRODUCTION

Blended teaching and learning in an integrated curriculum creates opportunities for learning that are not found in a traditional discipline-specific, pure classroom model. These opportunities include:

- the multi-dimensional analysis of complex issues and concepts
- the exploration of discipline domain problems from new vantage points
- the ability to collaborate with students and colleagues in a geographically and socially diverse community

However, developing blended, integrated experiences is complicated and can be expensive from both work-hours and financial perspectives. For example, in an integrated experience, faculty need to spend more time coordinating materials and exercises that support the desired outcomes than they would in a more traditional stand-alone, discipline-specific classroom course. When this integrated model is delivered in a blended format, the design team needs to coordinate delivery techniques in addition to integrating the material. The result is a highly orchestrated teaching plan that rivals the design and development of any complex system.

This paper explores Babson College's experience designing, developing, and implementing blended and integrated curricula for undergraduate, graduate, and executive business education. The paper examines the process from a systems thinking approach and attempts to develop an effective, repeatable, practice: model-driven design (MDD).

This paper also includes a brief history of Babson's migration from discipline-based teaching to integrated teaching. This migration serves as the foundation for Babson's recent evolution to the blended delivery model. A review of these transitions provides the necessary context for understanding the evolution to

model-driven design.

A note on language: While many definitions exist for integrated teaching, blended learning, and systems thinking, for the purpose of this paper, we will use the following working definitions:

- **Integrated teaching:** Teaching complex concepts and skills from a multi-disciplinary perspective.
- **Blended learning:** Using a mix of technologies and educational activities in support of identified learning outcomes.
- **Systems thinking:** A mindset for understanding how things work. It is a perspective for going beyond events, to looking for patterns of behavior, and to seeking underlying systemic interrelationships which are responsible for the patterns of behavior and the events. [1]

II. BABSON BACKGROUND

To understand the evolution of model-driven design at Babson, it is important to know something about Babson's history of innovation and integration. For example:

- During the early 1990s, Babson transformed the core of its course-based MBA curriculum from the traditional class/instructor model to an integrated set of experiences that immerse students in the study of business life cycles.
- During the mid 1990s, Babson transformed its undergraduate curriculum into an integrated business core/integrated liberal arts experience and migrated to a competency-based model for outcome measurement.
- In the early 2000s, Babson drew on its integrated MBA curriculum to launch a blended MBA program for corporate clients. Soon after, the College launched a similar open enrollment offering.
- Currently, Babson is redesigning its undergraduate intermediate management core experience (IME) and leveraging blended learning for integrated skills mastery and student self-service refresher requirements.

Through the early transitions from discipline-based teaching to integrated teaching, Babson's faculty developed the skills and understanding required to collaborate beyond the single instructor/single classroom model. Faculty and program administrators developed processes and language that support an integrated teaching and learning experience. This early work resulted in Babson's first model for visualizing and speaking about an integrated program.

In this early integrated model, the core of the MBA program was constructed to model the entrepreneurial life cycle. Students moved through modules that are focused on key business activities. Within each module the experience was organized in streams that cover integrated topics. Implicit in this model was a new language (i.e. module, stream) and a new visualization of the experience that was no longer tied to the semester model. The program was designed around a series of module maps that highlight and coordinate the activities of the streams within the program. These module maps are the perceptual model for the program.

When Babson designed and developed its blended MBA program, the integrated model was refined. For example, the concept of the integrated core stayed largely the same as the on-campus MBA, while the method of delivering this content shifted to a blended format. With this change came changes in the language used to discuss aspects of the program. Terms such as face-to-face days, discussion forums, and online sessions made their way into the language. Logistics also changed. While the blended MBA program planning still included content progression as it does in the on-campus programs, it also expanded to include planning the delivery of the content.

While much of the design work for both the on-campus MBA and the blended MBA was highly successful, both development efforts were time- and resource-intensive. Therefore, when the College decided to redesign the undergraduate IME program, Babson's curriculum innovation and technology group leveraged the design opportunity to develop a sustainable, repeatable process for design and implementation that was more time- and resource-efficient than the MBA programs had been. The goals were to:

- Arrive at a design that achieves the learning, teaching, quality, and cost objectives of the College.
- Develop an approach to design and development that is less resource intensive than prior design experiences.
- Develop a learning environment where the students can quickly understand how to use the technology platform and can focus on learning the curriculum content.

The result of this work is the concept and practice of model-driven design.

III. MODEL-DRIVEN DESIGN (MDD)

A. Overview

Model-driven design (MDD) is the concept of developing complex learning experiences through the use of a team model (how the team is staffed and empowered), a process model (how the experience is developed), and a perceptual model (how the experience is discussed and visualized). Model-driven design applies the basic principles of systems and software design to the creation of a complex curriculum. These systems and software design principles include:

- the creation of systems that can be visualized and understood at various levels of detail
- the assembly of larger systems from smaller re-usable components
- the ability for the system to change and adapt throughout its useful life

Successfully implementing model-driven design means committing to the following:

1. Using a common language

Within a single institution, a student may move among courses and faculty and discuss the same intellectual concepts and topics using different language. For example, in one class, the student may have "homework," while in another s/he may have "assignments." The implication in both situations is that the student has work to complete outside of class. While this language discrepancy may be acceptable in a single instructor/single class model, it creates large integration problems as we begin the development of a complex learning experience.

2. Establishing and committing to clear learning objectives

The establishment of clear learning objectives is the point from which all other curriculum decisions are made. For example, as a faculty member argues to include a certain reading or exercise that he or she has "always assigned," that professor must determine whether that activity helps the students achieve the established learning objectives. If it does, it should be assigned. If it does not, it should be cut or the objectives must be modified.

3. Working in new units of instruction

The majority of US higher education institutions structure their planning around semesters, courses, and class sessions. While this structure is, arguably, an effective one for administering the learning process, it does impose time and segmenting constraints on curriculum design. As we begin to design integrated and blended curricula, it is important to free the design from these existing constraints so

that the learning objectives and the delivery model can drive the segmentation.

4. Developing content in stand-alone learning units

A stand-alone learning unit provides an entry point and exit or conclusion that allows an individual to learn content in a meaningful, discrete experience. It must set context, present information, and conduct mastery exercises such that by completing the learning unit, the individual will be able to demonstrate competency in established learning objectives.

B. MDD — Team Model

Most integrated and/or blended design initiatives require a cross-discipline, cross-functional team. Even the creation of small units of instruction delivered in a blended experience requires skills that are rarely found in a single person. Frequently the team includes a faculty member (or subject matter expert), instructional designer, and instructional technologist. Often a graphic designer is also part of the design team. In addition to these core production skills, the team must possess the understanding and authority to drive the design and the resulting implementation.

For a large-scale initiative, such as the creation of an entirely new academic program, several teams are employed at different stages of the project. As the project grows in scope, team size must be carefully balanced with the proper make-up of the faculty experts for the subject matter, administrators, and specialists versus the logistics of meeting and working together.

Successful projects leverage a sponsorship approval model. A **steering committee**, usually an academic decision-making body, sets the overall goals and directions for the program and reserves the right of final approval. This group also helps to sell the completed design to the rest of the institution.

The **high-level design team** (HLDT) is the working group that builds the perceptual model. It is driven by faculty division representatives who are empowered to commit their colleagues to the new design. It drives the project timeline and refines the goals for the implementation teams. The HLDT also includes instructional designers and technologists in an advisory capacity so that implementation feasibility and new opportunities are factored into the design. Program administrators also serve an advisory role so that logistical implications and costs are discussed during the design. The goal is to arrive at an innovative, implementable design that is made final before content development.

Development teams work within the bounds of the high-level design to find or create source materials and, where required, to create technology to support teaching and learning experiences. These development teams can work in parallel, compressing the overall time required to build out the new program.

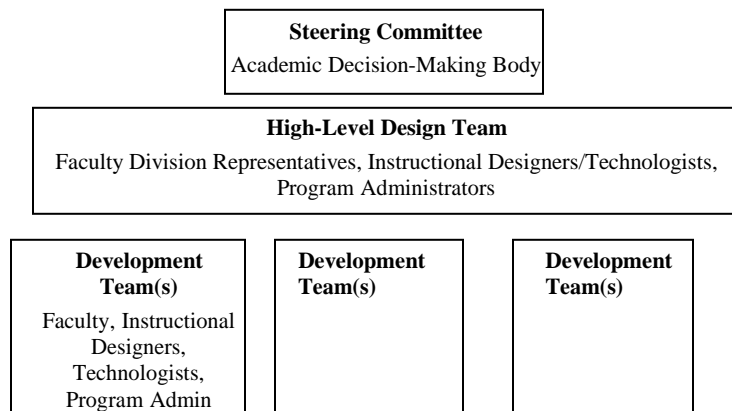


Figure 1. Large-Scale Project Team Structure

C. MDD — Process Model

In the traditional teaching model (one instructor teaching a single discipline in a classroom) many degrees of freedom exist such that just-in-time session planning or content development carries a low cost. The professor can adjust to student reaction in real time. The content can be developed “on the fly” through the of verbal discussion and white board/PowerPoints. In this environment, the results of this technique can be positive.

Adoption of a blended model raises the costs of the just-in-time model and adds delivery risks that can be unacceptably high. A discussion forum that is not well-planned or a Web presentation that fails to communicate key information may result in student drop-out rather than student learning. Additionally, delivery requirements need to be coordinated with technology support staff to ensure the uninterrupted access to services and content. These and other risks warrant a deliberate development process that is understandable and repeatable.

While no singularly correct process model exists, it is critical that one is adopted or developed and that its constraints and requirements are respected. As a starting point, the design team can adopt a modified waterfall model, as outlined below [2]:

The waterfall approach (see below) is an established life cycle model for system development. The modified waterfall approach, when followed, provides a process for yielding a high-quality learning experience. The waterfall model follows a set of distinct prescribed steps. Each step is independent of the others. The process is document-driven, meaning that at the conclusion of a step, document(s) (physical or digital) is/are passed on. The passing of finalized documents triggers the start of the next step. Issues discovered in subsequent steps force the process back up the waterfall and the consequent modification of hand-off documents.

A modified waterfall permits the slight overlapping of steps and supports the notion of concurrent sub-projects. The concurrent running of sub-projects can reduce overall development time and can help to expose potential issues earlier in the design and development process. In the case of curriculum design the unit detailed design and development processes can generally run in parallel for each major unit of the design. This process is achievable as long as the high-level design has been completely vetted and is finalized.

While a team will want to customize its process based on the project requirements and culture, below is a skeletal process that can be used for programmatic curriculum design:

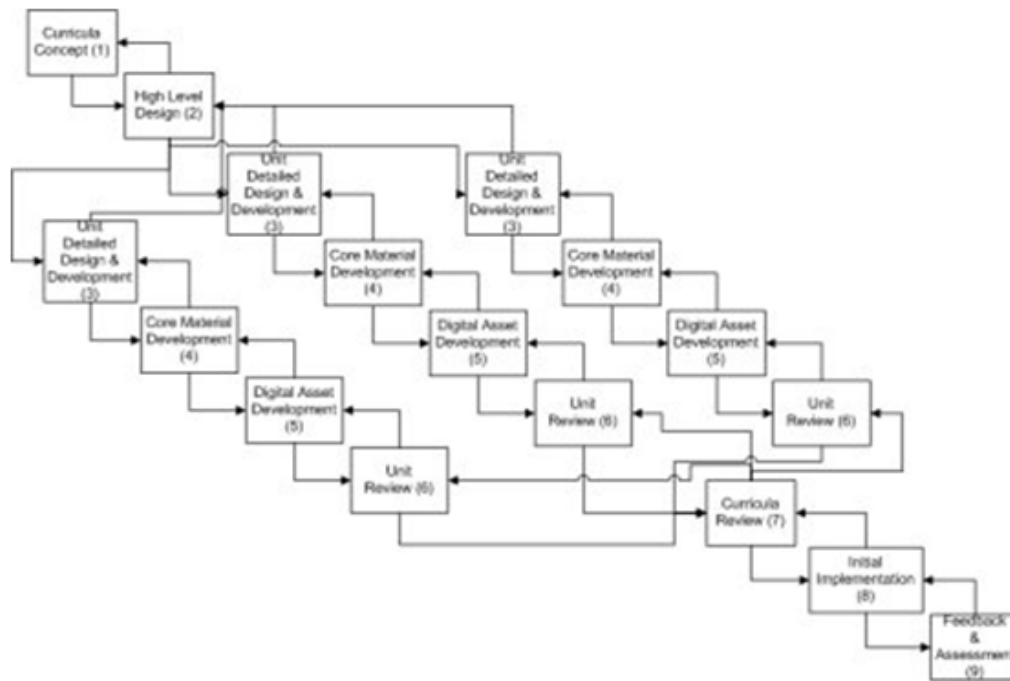


Figure 2. MDD- Modified Waterfall Process Design

1. Develop a curriculum concept. What are the major features and components for the program? What are the goals and objectives? What are the distinguishing features of this course of study? What are the assessment criteria for the project's success?
2. Develop a high-level design. Develop a language and visualization that tells the story of this program. Finalize the perceptual model.
3. Based on the perceptual model, establish a detailed design for each unit of the curriculum. This can include administrative processes.
4. Develop or identify the core or source materials for the unit.
5. Design and develop all supporting digital materials and exercises that support the learning objectives for the unit.
6. Review and refine each unit of the curriculum for completeness, effectiveness, and support of the high-level design objectives.
7. Review the entire curriculum for completeness, effectiveness, support of the high-level design objectives and overall quality.
8. Implement (teach) the new program.
9. Based on the initial and ongoing teaching experiences, assess the program's effectiveness for future.

D. MDD — Perceptual Model

The perceptual model uses language and notations (sketches or pictures) in a common format that together describe the curriculum. The perceptual model is the framework for the design. Once the perceptual model is populated with specific details, it becomes a vehicle from which the design team(s) can review, refine, and negotiate changes to the curriculum while still in the design phase.

1. Language

At the foundation of the perceptual model is a common descriptive language. This language supports the development effort and provides a clear learning environment for the students. Language needs to focus on the descriptive structural elements of each unit of the curricula as well as the instructional actions required to participate in the learning experience. The specific language selected is not as important as the consistent application of it for the entire curriculum.

For example, in one curriculum, structural elements might include program, semester, and class while another curriculum might use program, module, stream, and session. The specific taxonomy does not matter as long as one is selected or developed and applied consistently. It is this consistent application of language that develops a community-wide understanding of the new model. Similarly, instructional actions must use a consistent classification language. Instructional actions are those entities and activities that faculty and students participate in and utilize throughout the program. Instructional actions can include lecture, meeting, discussion forum, book, assignment, reading, and so on.

2. Notation

The act of sketching or modeling a design with pictures and symbols is nothing new; it has been applied to systems development and engineering for quite some time. Its use provides a visual context from which people can learn the design and develop a deeper understanding of the implied complexities of the solution. Using a set of design notations for curriculum design achieves these goals and more.

As with language, the specific notation is not nearly as important as the consistent use of a single notation across the entire project. The notation builds on the language selection by incorporating the language constructs into the pictures.

a. Example Notation — Partial Model

This partial example describes the curriculum as a series of related boxes or units. The picture is read top to bottom, left to right. The higher-level units are made up of the lower units. The width of a unit denotes a relative amount of time that the activity requires. Within a unit there are descriptors that provide details about the unit. The major units are program, module, stream, and session. In this example, a program has one or many modules, a module has one or many streams, and a stream has one or many sessions.

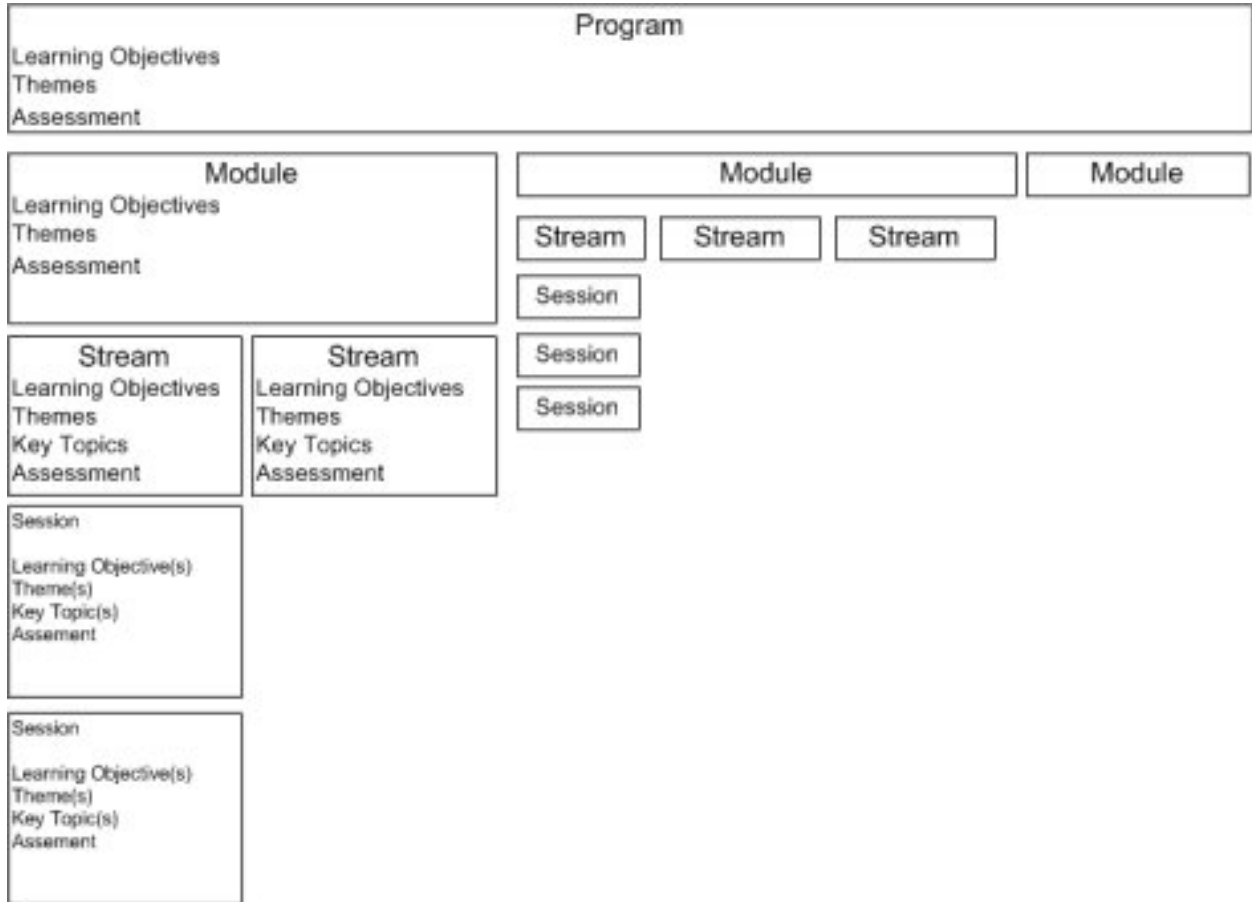


Figure 3. Partial Model

From a pedagogical perspective, the program is driven by learning objectives, themes, and assessment. This implies that the first step of the design is to identify the objectives that the learner should achieve at the completion of the program. These objectives cascade through the modules, streams, and sessions. Supporting themes and topics are developed so that the entire program of instruction supports the top-level objectives. Finally, the team needs to develop programmatic assessments that demonstrate an achievement of the learning objectives.

This model, when fully populated, provides a rich overview of what the learner will accomplish in the program (i.e., learning objectives) and the program structure. It also helps the detailed teams understand the magnitude of the detailed development activities. Content and learning experiences are created in support of each session.

E. MDD Benefits

While model-driven design requires a rigorous commitment to team, process, and the perceptual model, it creates benefits and efficiencies for the design team, the development team, and enhances the sustainability of the new curriculum.

A primary benefit is improved communication and understanding across the institutional community. A clear vision and understanding of the curriculum create the opportunity for engagement and contribution by people who might otherwise fear the change. It allows new faculty and students to learn the structure and expectations of the program faster than they otherwise would and highlights opportunities for participation. It also supports the creation of a strong, consistent marketing message and helps to clearly

position the program and institution.

From a human perspective, model-driven design takes some the work out of the curriculum innovation process. Institutions committed to ongoing innovations can select a longer term model and stick to it. Energies normally spent on the how-to of innovation can be eliminated or focused on the content of model.

From a technological perspective, some of the benefits of this approach include:

- creating a learning technology platform: learning management system (LMS), assessment system, conferencing system, stream media system, directory and authentication service that support the goals and language of the perceptual model.
- establishing templates and technology frameworks to support the development of teaching and learning materials.
- developing instructional and how-to materials that enable students and faculty to learn how to use the technology platform.
- beginning the technology implementation earlier and running it in parallel with the content development.
- enhancing the ability to easily generate digital content, including modeling learning units in a reusable data store such as XML or an SQL database and generating learning unit views by learning style. These rendering engines can be developed based on the model and have the ability to serve a wide range of content.

Finally, the model makes programmatic change easier to implement in real time. Adjustments to the curriculum are easier to visualize, scope, and implement based on a model-driven approach. Interconnections and “down stream” implications can be discussed and negotiated prior to implementation. During implementation, clear lines of delineation exist, containing the change to the desired units of the curriculum.

Throughout the life of the program, the model serves as a self-documenting living map, the language allows the institution to talk about it with a common understandable meaning, and the process provides a repeatable mechanism for driving change.

IV. MODEL-DRIVEN DESIGN EXAMPLE

A. Redesigning the Intermediate Management Experience (IME)

1. Project Background

The IME is part of the Babson College undergraduate core curriculum. It is taken by all Babson undergraduate students over three semesters starting in a student’s sophomore year. It is taught by a team of professors who are experts in their respective fields and conveys the interaction of each facet of business with the others. The students examine real business problems from different or combined perspectives and analyze the various factors that may affect the ability of a business to execute its strategy [3].

While this highly integrated program has been well-received over the past six years, the original design complexity created challenges on many levels, including:

- students transferring into or out of the College
- students pursuing alternative and/or advanced learning experiences while at Babson or after the completion of their degree
- faculty staffing
- overall program administration

With these issues in mind, and with the overarching goal of maintaining, if not improving the quality of the program, the College embarked on a redesign process. The IME project followed the disciplines of model-driven design and delivered a new program in less than two years.

B. IME — Team Model

The IME project was sponsored by the Babson College undergraduate decision-making body (DMB). This permanent committee is responsible for the undergraduate academic program. Among the many goals that the DMB established were:

- develop high-quality curricula
- address any weaknesses found in the original IME
- attempt to reduce delivery complexity and cost
- leverage teaching and learning technology in the delivery of the program

The DMB chartered a high-level design team composed of faculty, administrators, instructional designers, and technologists to develop a high-level design. While the high-level design team had many specific charges, among the most critical was the one to leverage learning technology in this residential program to promote learning outside of the integrated physical classroom. The DMB team believed that the quality of time spent in the classroom would increase if the students were provided with self-study experiences that:

- allow students to practice concepts and methodologies at their own pace
- refresh the student's understanding of concepts taught in previous semesters
- provide students with access to a "toolkit" for use in upper-level electives

At the conclusion of the high-level design, detailed design teams were established. The detailed design teams were primarily faculty representatives from each academic division and instructional designers and technologists serving in a consulting capacity. The detailed design teams worked in parallel and were responsible for fleshing out the design down to the class session, assignment level of detail. Finally, key faculty were called on to find and develop the teaching materials and notes that are required to support the new IME design.

C. IME Process Model

The workflow followed a modified waterfall approach. Key documents were established for major milestones of the redesign. The documents included:

- a high-level design narrative that identified the rough structure, goals, and objectives for the program
- a model overview that set the language and conceptual model for the program design
- a completed high-level design broken down by semester
- a detailed design by class session

Each of these documents was made final before moving into the detailed development of teaching and learning content. Team meetings were structured to provide review and feedback at each development step. The process was collaborative and consensus-driven.

D. IME Perceptual Model

The IME can be thought of as a hierarchy of activities and experiences that result in an overall program of study. In a partial, highest level view, the IME is described as follows:

The IME is composed of a number of semesters and transition or summary exercises. In fact, we may want to view the transition exercise from the previous semester as a prerequisite for the current semester. During

each semester, we address some number of disciplines and/or themes. From this graphic we see that the entire IME can be described at a high level as the summation of:

Semesters	A period of time that achieves a number of learning objectives.
Transitions	Reviews, exercises and assessments that demonstrate mastery of work in the prior semester and that set context for the upcoming semester.
Disciplines	A body of knowledge tied to a specific academic subject area.
Key Topics	A specific area of knowledge that supports the understanding of the discipline or theme.
Themes	A body of knowledge tied to many disciplines. Themes can be taught as independent concepts or taught as part of a discipline.

Table 1. Intermediate Management Core Experience (IME)

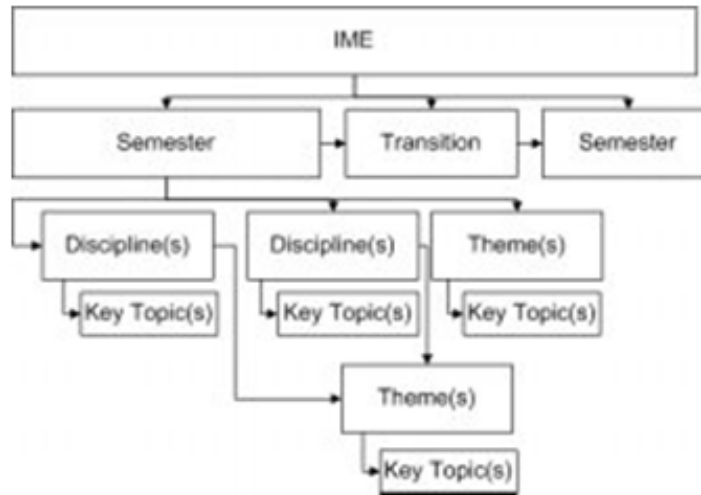


Figure 4. IME Discipline or Theme Model

If we disaggregate a discipline or theme, we expose its key components and can view their relationships.

Prerequisite disciplines or themes	Themes and disciplines that must be mastered prior to entering the current theme.
Learning objective(s)	The key objectives or outcomes that the theme will achieve.
Key topics(s)	A specific area of knowledge that supports the understanding of the discipline or theme.
Assessment(s)	Exercises and activities that, when completed to a specified level, demonstrate a mastery of the material.

Competency Connection(s)	Connections to Babson’s competency model.
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Table 2. Relationship Components

Finally, if we disaggregate a key topic, we see that the key components for it include:

Overview(s)	Presentation and reading materials that introduce the learning objective.
Activities(s) & Exercise(s)	Student work that reinforces the overview(s) and key topic(s) through active learning.
Assessments(s)	Exercises and activities that, when completed to a specified level, demonstrate a mastery of the material.

Table 3. Topic Components

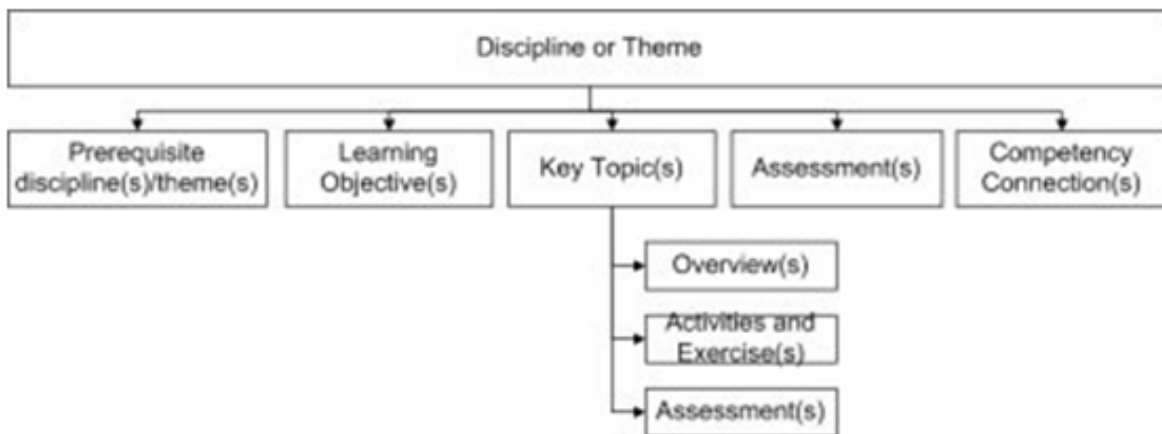


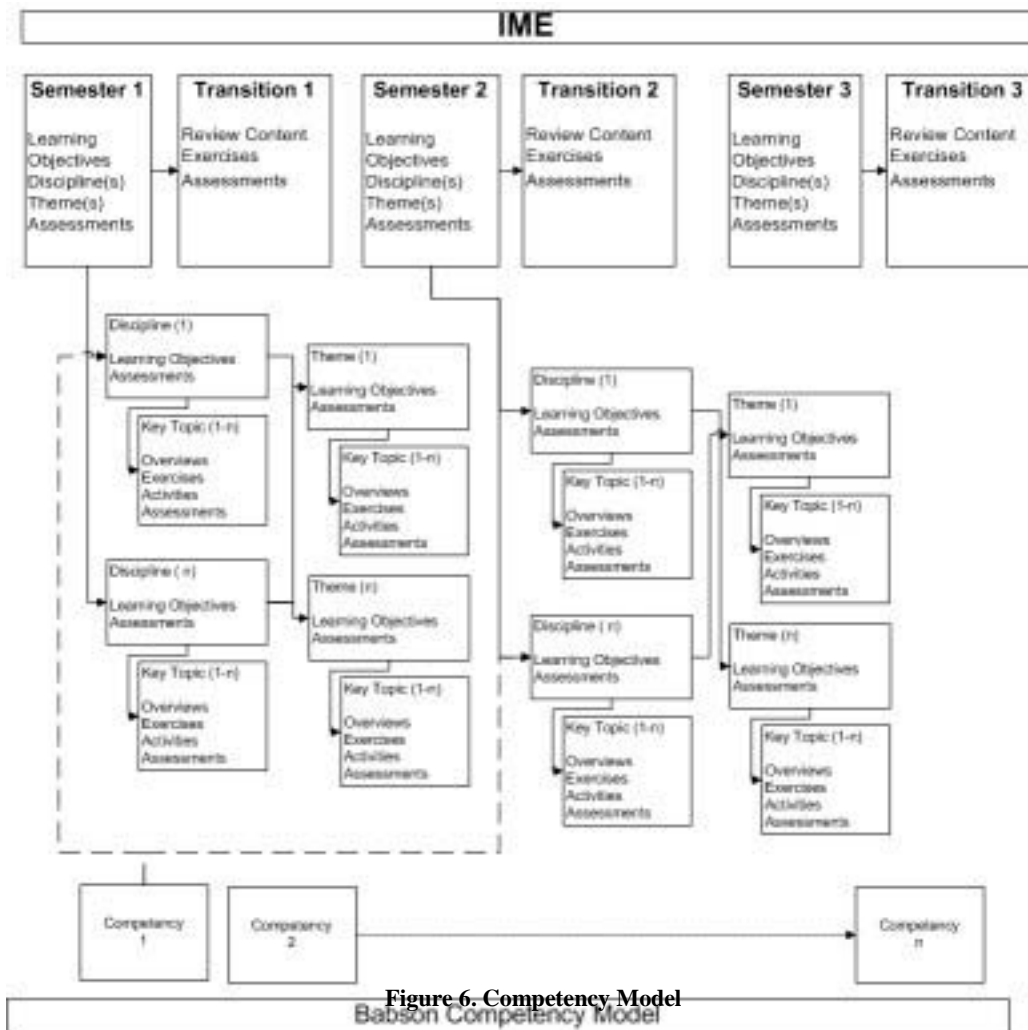
Figure 5. Discipline Components

We see from the model shell (below) that when it is fully populated, we are able adequately to describe the IME structure and flow before the creation of detailed content. We also achieve a secondary benefit of highlighting competency connections. (Competencies are key abilities that Babson students should possess at the complete of their college experience.) In essence we are now able to explicitly create themes and content that can serve a dual purpose of IME delivery and competency exploration.

This model provides the opportunity for:

- a theme to repeat over time at different levels of learning and activity
- the ability to package disciplines and themes as portable learning objects
- separate content for transition/summary activities that could be entirely supported with/by eLearning
- the ability to change components of the model over time

1. A partial overall view of the IME Structure



2. IME Implementation Benefits

Once the model was made final, teams were established (organized by IME semester) to develop the session content and learning units, populate the learning management system (LMS), and begin teaching the first offering of the new IME.

During the implementation phase, the teams benefited from model-driven design and the resulting model in several ways:

- a clear structure guided the development of source materials
- a clear understanding of the timing and sequencing of instruction was in place
- a faster and more flexible technology implementation (see below)
- the creation of shells or templates for the LMS, the online assessment engine, and overview Web site that follows the language structure of the model prior to content development
- the creation of reusable rendering engines, reducing the level of effort for instructional asset development

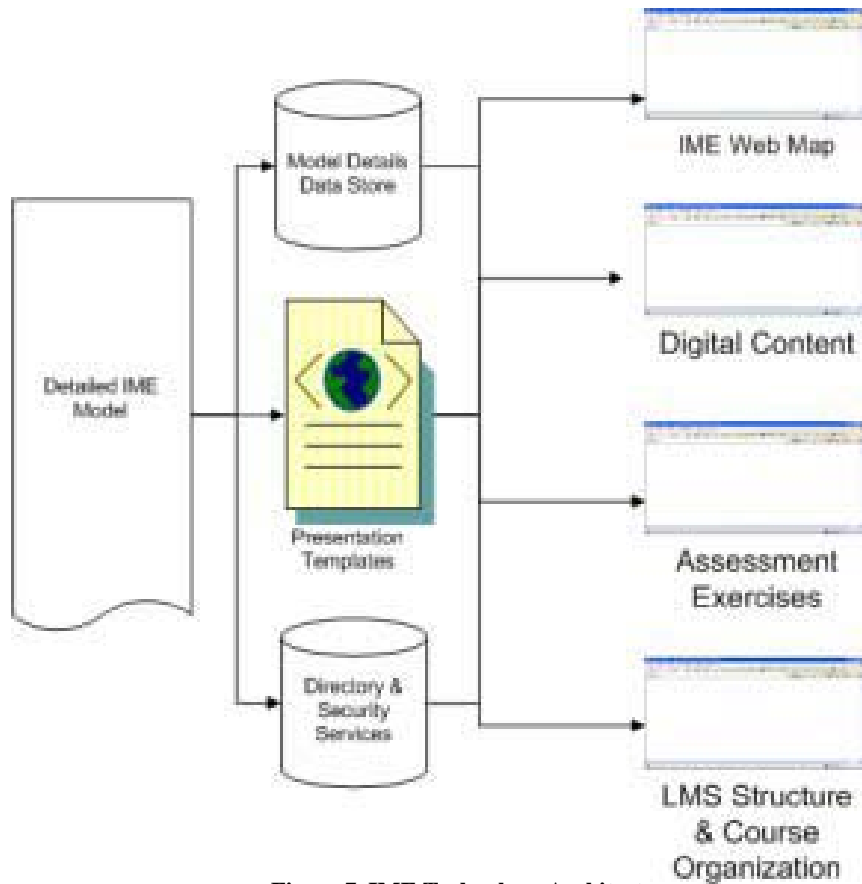


Figure 7. IME Technology Architecture

V. NEXT STEPS

As a concept and a practice, model-driven design has proved beneficial for Babson College. Our initial experience has been the ability to develop a high-quality, integrated program in a sustainable, repeatable manner. It has created the opportunity easily to introduce technology into the IME program. It has also established a methodology to support change and refinement of the IME curricula. We have begun to use this same approach for graduate and executive education programs and believe that we will derive similar benefits from the design of these programs.

From a technology perspective, we continue to purchase and develop authoring and delivery technologies that support the notion of separation of model, content, and delivery platform. We view the world as a set of templates that support the model and that free the faculty and subject matter experts to change content as warranted.

From a disaggregation, or learning unit, perspective, we have begun to see higher levels of reuse and sharing among faculty. The creation of learning units that support the model and that can stand alone in their usage allows the College to invest more resources in any given learning unit, since it will be used by a larger number of students. It also encourages faculty to develop sophisticated learning segments, since their broad adoption in the curriculum leverages the faculty time invested in the design and

development.

So what comes next? For Babson, we think it is the ability to share models and learning units beyond the borders of the institution. Conceptually and practically, we support the many initiatives that are working toward open platforms for learning management systems and exchangeable content. While many are approaching this issue as a technology and packaging standards issue (which at some level it is), we believe that other hurdles include model-based thinking and a quality assurance or rating system. Additionally, the notion of the learning unit having responsibility for setting context and for covering an appropriate scope of content is a major issue with cross-institutional model-driven curriculum development.

VI. REFERENCES

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VII. ACKNOWLEDGMENTS

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