The Ford Partnership for Advanced Studies: A New Case for Curriculum Integration in Technology Education

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Introduction

The Ford Motor Company launched a new pre-engineering curriculum for high schools in the Fall of 2004. Building on an earlier manufacturing program, the development process for the Ford Partnership for Advanced Studies took approximately three years. Ford and the course designers wanted the new program to incorporate the best principles and practices of technical/technology education at the secondary level. Therefore a conscious effort was made to integrate national curriculum standards in the design phase; in addition, there are explicit connections in the instructional materials between the academic and technical content for both teachers and students. This article reviews the rationale and the strategies for academic integration, and shows how the new Ford program is a prominent example of effective curriculum development in technology education. The product of this process is a coherent series of five courses that are educationally sound and that address national standards in academics, technology, and engineering.

Background

While Henry Ford is widely acclaimed for his achievements in the automotive industry—achievements which allow many to acknowledge him as the man who put America on wheels—he was also one of the first businessmen who recognized the role that responsible corporations play in building and sustaining communities. Under his leadership, Henry Ford created a variety of schools and established supportive relationships with many educational institutions of his day (Ford Motor Company Fund, 2002). Following in this tradition of support for learning by all members of the community, the Ford Motor Company, recognizing the industry-wide need for more young people to pursue careers in engineering, math, science, and technology, created the Ford Academy of Manufacturing Sciences (FAMS) in 1990 to expose high school students to the potential of high-tech careers in manufacturing. FAMS consisted

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of four, one-semester high school courses: The World of Manufacturing, Statistical Methods for Manufacturing Quality, Workplace Technologies and Applications, and Case Studies in Manufacturing. It was designed for juniors and seniors and included a summer internship. In the mid-90s an alternative configuration was introduced with additional courses in Workplace Communications for the ninth grade, Manufacturing Organizations for the tenth grade, and Information Systems for the eleventh grade.

FAMS is a “rigorous academic, personal development, and work-based program” (Ford, 1998, p. 1) that provides students with learning in science, math, technology, and communication skills. The curriculum was positioned as a pre-engineering program; it was not intended to provide remedial instruction, because students needed Algebra and grade level reading skills to succeed. In 1994 FAMS was awarded a Certificate of Honor by President Clinton for recognition as an exemplary school-to-work program. In 1998 FAMS had been implemented successfully in 76 schools throughout the country, including Canada and South Africa, and served over 5,000 students.

Building on this legacy, Ford decided in 2000 to develop the next generation of courses to be called the Ford Partnership for Advanced Studies (PAS). The goals were to create a program that uses 21st century technology, is flexible for use in non-traditional settings such as after-school and summer venues, and to use national academic standards to assist in the design of content (Educational Development Center, 2000). Although the original curriculum included substantial academic content, this new development process provided an opportunity to make a more conscious alignment of the program objectives with national academic standards. The idea of integrating academic and technical content is not new, but the new Ford PAS program is a high profile example of the design and implementation of an integrated, interdisciplinary curriculum.

Conceptual Framework

Without a strong academic foundation, technical programs can have a narrow focus on entry-level job skills and may limit students’ potential for postsecondary education; and, without an occupational context, academic education can lose its relevance and applicability to situations in which students are interested. As an answer to these two common learning limitations, the integration of academic and technical curriculum employs the “context of work, family, and community (i.e., all aspects of modern life) as the vehicle for engaging students in learning the most central, essential aspects of the academic disciplines” (Bragg, 1999, p. 186). The practice of curriculum integration therefore was used as the conceptual driver to develop the Ford PAS program so that students would be immersed in a realistic engineering environment while drawing on many other high school courses.

Definition of Integration

The topic of academic integration is often discussed in connection with other terms such as contextual learning, applied academics, applications-based instruction, inter- and cross-disciplinary studies, and career majors. Loepp (1999) defined integration as connections among a wide range of disciplines, "conscientiously applying methodology and language from more than one discipline to a theme, topic, or problem" (p. 21). Similarly, Johnson, Charner, & White (2003) described integration as "a series of conscious and informed strategies used to connect academic and vocational content so that one becomes a platform for instruction in the other over an extended period of time" (p. v). Building on the "all aspects of industry" framework, Finch and his colleagues (1997) suggested that curriculum should include instruction on a "wide range of industry or field-wide functions, concerns, issues, and technological knowledge and skills" such as community, environment, economic, finance, health, labor, leadership, management, planning, safety, and underlying principles of technology (p. 8).

Rationale for Integration

The rationale for integrating academic and technical subjects has been eloquently described by a number of authors. For example, Seemann (2003) made the case that to make informed technical decisions students should consider a wide range of criteria such as social and environmental factors. His holistic position "asserts that to understand the particular one must understand its relation to the whole" (p. 28). Further, to develop and transfer technical knowledge, it is important to understand the "why" in addition to the "how." Understanding the interdependencies between subjects helps create meaning. Importantly, educators need to teach these relationships explicitly in contrast with task and skill approaches, or short-term vocational skills. Technology is "context sensitive" (p. 36) so that in making choices and designs for technical projects the social and environmental setting needs to be considered as well.

Flowers (1998) argued that the result of typical design activities is a focus on the material product, whereas problem solving can include changes to systems or even maintaining the status quo. He contended that technology should help control the environment and meet human needs is a Western bias. Instead, students should be encouraged to consider a broad range of solutions including non-technological ones; they should weigh the short-term and long-term costs and benefits, and consider what is "best for the individual, for the culture, for future generations, and for the environment" (p. 24).

According to Edling and Loring (1996), a major objective of education should be to keep open a range of options for students, not simply skills for work or academics for college. Even though there is a well-developed body of knowledge for core academic subjects—and it seems to make sense to teach them in isolation—the reality of modern life emphasizes context, relationships, and wholes, which is best exemplified by occupations. So teaching academics in the context of a profession such as engineering provides a framework for higher, reflective learning which includes analysis, synthesis, and systems thinking; and teaching engineering using a foundation of academics and process skills helps students grasp and apply the concepts from both areas.

Benefits of Integration

Today's employers want workers to use initiative and solve problems, skills previously associated with employees who had been to college and have a good academic foundation in subjects like statistics. Plank (2001) suggested that an integrated curriculum provides students with a strong academic program and a foundation in work applications so that they can pursue a variety of levels and combinations of work and college. Such a program may also offer other motivational benefits like greater relevance of academics, working harder in academics, and more commitment to school in general.

In their discussion on using contextual learning to build cross-functional skills, Freeman, Field, and Dyrenfurth (2001) pointed out that skills such as teamwork, communication, decision making, managing resources, and information gathering are important for performance and stability in employment because employees are required to interact across functional boundaries. Thus a purely academic or technical education is not enough to prepare students for modern realities. The integrated approach often uses instructional strategies designed to build cross-functional skills such as cooperative learning which promotes positive relationships and helps students put material into their own words; contextual learning which helps students process new information by making sense of it from their individual frame of reference; and experiential learning like work-based methods and service learning projects.

The project method is typically used for integrating technical and academic subjects. Verner and Hershko (2003) reported that projects also promote the "development of systems thinking, problem solving, self-study, and teamwork skills" (p. 40). Project groups often include students with different strengths in subjects such as math, physics, and technology; and individuals are responsible for different functions of the group. The project report is a major component of the process which includes collecting and documenting activities, and making a final presentation. The authors found that students contributed significant time to self-directed extracurricular teamwork, demonstrated increased curiosity and motivation to inquire about other subjects related to the project, and took personal initiative in promoting and funding the project. Using the project method was one of the major objectives of Ford's development effort for the new program

Development of Integrated Programs

Hoachlander (1999) described some of the requirements for program development. To be effective, academic integration must accomplish a well-defined educational objective—not just be an engaging activity—and the work-related context must be of genuine interest to the students. A sustained, systematic curriculum also requires substantial time, resources, and expertise, yet "the stock of sound, tested materials is still quite limited" (p. 2). Once developed, the integrated curriculum may help the 60-70% of students who do not learn well when academic material is abstract or disconnected from practical applications. To increase the validity of courses, educators should use national and state standards for each academic subject as a basis for designing curriculum; national skill standards from the appropriate industries serve the same function for the technical content.

Bailey (1997) reported on a conference of professionals who had developed standards in either academic subjects or industry areas (i.e. electronics, metal working). Attendees used both groups of standards to design integrated projects; the standards can strengthen each other because educators may not understand the technical dimensions of the workplace and employers may not understand the academics they need. Standards are generally developed in isolation: industry standards mention academics, and academics make reference to workplace applications, but the connections are not explicit and the performance levels are not defined. Further, academic standards are established based on what students need to know to progress to the next level of education, and do not consider objectives outside of school. Meanwhile, the academic standards in industry are set very low (some may not even require a high school diploma), although they may be under-estimating what employees need to know. The area of biggest overlap is the process-oriented skills: problem solving, teamwork, inquiry, and communication. Employees use (and therefore students should learn) a variety of information sources to investigate issues and come up with answers, and they use different means and media to communicate results. So curricula should be developed from both sets of standards by performing a crosswalk to create complex examples and scenarios, and utilizing appropriate teaching strategies.

Implementation of Integration

One way or another, integration requires that teachers are given sufficient resources so they can collaborate with colleagues in different subject areas. This may necessitate individual and system changes, but the payoff is that both academic and technical courses can be strengthened. Writing about technology education, Linnell (2001) said that in order for technology to become a vital part of the curriculum in public schools, technology teachers need to collaborate with different disciplines, which will help gain acceptance for the technology curriculum.

Loepp (1999) identified several important factors in implementing an integrated curriculum. First, educators need to shift their approach to teaching from didactic instruction to constructivism to allow students to discover and apply knowledge in their problem-solving. Second, professional development is required for teachers in other content areas and in different pedagogy so teachers can move from isolation to members of learning communities. A third factor is that teachers need to be proficient in facilitating small group learning, especially experiential, hands-on, lab-based instruction.

Using authentic assessment strategies such as portfolios, performance and demonstration, and evaluation rubrics is a fourth factor in implementing integration. Ultimately, such changes will require public information strategies to help the community understand that a different education model is being used, and systemic changes in teacher preparation, certification, and assessment may be required.

The Ford PAS Curriculum

The development of the new version of Ford's existing pre-engineering curriculum was seen as an opportunity to incorporate the best practices of technical instruction for high school students. The development team used curriculum integration to establish a foundation for the program; they took into account many of the principles of integration such as including all aspects of industry, using manufacturing as the learning context, developing process skills, providing a crosswalk of curriculum standards, and insuring professional development for prospective teachers.

The process began in the spring of 2000 and the first two courses were ready for implementation in the fall of 2003. Several schools started the new program at that time by transitioning from the former FAMS program or by trying out selected modules. The complete Ford PAS program consists of five semester-long courses, each containing three six-week modules, and is designed to be taught in sequence starting in the tenth grade. The name of the new program was changed to the "Ford Partnership for Advanced Studies" to expand the meaning and scope of the program (beyond manufacturing), to emphasize the partnering with community businesses and post-secondary education institutions, and to distinguish the high school curriculum from general preparation courses.

Using a hybrid version of the backward design process (Wiggins & McTighe, 1998), the curriculum development team first identified the performance outcomes. Second, assessments were designed that address the various national standards as acceptable evidence of achieving the desired results. Third, the entire Ford business cycle and processes were used to develop learning activities that exemplified sound educational principles.

Needs Assessment

The project began by the awarding of a planning grant to the Education Development Center, Inc. (EDC) in Newton, MA. EDC first surveyed current FAMS students and teachers, a process that yielded several interesting discussion points. The responses were overwhelmingly positive, but there was also consensus that the program was somewhat outdated, especially in its presentation and use of technology. Teachers and coordinators were impressed with the philosophy of FAMS and its emphasis on communication, teamwork, and problem solving. For students, the most engaging part of the program was their participation in internships, field trips, and job shadowing. Teachers also expressed the need for a website that would provide curriculum activities and a national network of FAMS programs.

EDC also conducted a search for curricula comparable to FAMS in goals and focus. A total of 10 programs were investigated that potentially could provide ideas for development; they included "What's up in Factories?" developed by public television's WNET; "Project Lead the Way" funded by the Charitable Venture Foundation; and "IDEAS: Integrated Design Engineering Activity Series" by the American Society of Mechanical Engineers. Although each of the programs have their strengths and have experienced success with various groups of students, the Ford planning team envisioned a broader curriculum that would get students interested in engineering in a variety of business settings. While some of the existing curricula were seen as specialized in certain content areas, the new program was intended to introduce students to the larger world of business, literally from concept to consumer.

A third step in the assessment process was meeting with Ford engineers and other key staff to identify some of the major themes that should be included in the new curriculum. Ford's education and training professionals were interviewed to get their perspective on the important topics that are frequently requested by business units for training, as well as what all new employees need to know. Public presentations made by Ford engineers were reviewed to determine some of the topics that tend to surface repeatedly. Representatives from professional engineering associations were also contacted. After much discussion a list of seven overarching concepts were chosen: Systems Thinking, Lean Production, Diversity in the Workplace, Globalization, Environmental Sustainability, Six Sigma Quality, and Consumer Focus. The idea was that these themes—what Wiggins and McTighe (1998) call the "big ideas"—would be threaded through all the modules and learned by broad-based applications. A module on business decisions, for example, should highlight the necessity of balancing the need for financial profit with social and environmental concerns.

The new Ford PAS program includes three core curriculum elements. First, national academic standards are the basis of all instructional materials. Curriculum standards were procured from the following organizations:

- *Math*: National Council of Teachers of Mathematics (2000)
- *Science*: National Research Council (1996)
- *English:* National Council of Teachers of English (1996)
- *Social Studies*: National Council for the Social Studies (1994)
- *Business*: National Business Education Association (2001)
- *Economics*: National Council on Economic Education (2000)
- *Engineering*: Mid-continent Research for Education and Learning (2000)
- *Educational Technology*: International Society for Technology in Education (2000)

- *Technological Literacy*: International Technology Education Association (2000)

The instructional developers made conscious connections with these standards as they created and then reviewed the learning activities. For example, they identified areas of each activity where math could be used to quantify, describe, or display observations and conclusions; they identified areas where communication with diverse audiences, both orally and in writing, was necessary to successfully complete the activity; they identified areas where scientific approaches or principles would clearly support and explain observations and conclusions; and they identified areas where information technology was critically necessary to research, communicate, and present findings. Projects typically include a major skill area, e.g. conducting research on alternative materials for a product, which is aligned with specific standards such as physical science and conducting investigations.

The second core curriculum element is interpersonal and human performance skills which are included because they are critical for success in college, work, and life. Based on the SCANS skills (Secretary's Commission on Achieving Necessary Skills, 1991), they are divided into the areas of communication, thinking and decision-making, interpersonal, and lifelong learning. Many of these skills are also addressed in the English and Social Studies standards. The third core element to serve as the basis of the curriculum is consumer-focused business concepts which provide a realistic context for learning. This area includes the themes and technical subjects such as planning and efficiency, quality assurance, global citizenship, and consumer-driven design.

Curriculum Development

The curriculum development process began in the summer of 2001 with a contract by Ford with EDC. With the foundation of the curriculum and major themes established, the design team started contacting additional subject matter experts and searching for learning resources. Existing training materials from Ford, with the exclusion of some proprietary items, were made available to the curriculum team; they reviewed training programs on marketing, statistics, and product design for example, and considered how these materials could be adapted for the current audience and purpose. Professional associations such as the Society of Manufacturing Engineers, the Society of Automotive Engineers, and the National Council on Economic Education provided some promotional and educational materials. Other associations dedicated to specific issues like alternative energy were considered as sources of technical expertise and instructional materials. As a result of this development phase the curriculum team assimilated these ideas into a draft outline of five courses and 15 modules, along with a pool of resources for detailed information.

Next, the development of the first module began in earnest. The module format was designed and revised over a period of six months until a basic template was established, one which would serve as the basis for all subsequent modules. The format was also set for each module's Teacher's Guide which includes an overview, a brief description of each of the activities, a module planning calendar, a list of learning goals for each activity, and a list of the academic standards addressed in each activity. To illustrate the alignment with academic standards, the first activity in Module One has a learning goal which states "describe the consequences to society of the widespread use of new products". The next column shows the academic standard that is associated with this topic, in this case NCSS 8b and 8c, which refers to the National Council for the Social Studies standard on Science, Technology, and Society. This section is followed by a detailed description of the activities and provides a breakdown of each session. Suggestions for preparation, materials needed, and new vocabulary words are also included. Finally, there are specific process and content instructions provided for the teacher—in other words, lesson plans. There are additional resources for the activities such as background information on technical areas, worksheets, assessment rubrics, and quizzes, and there are suggestions for the teacher to contact local organizations for case studies and tours.

The Student Guide also includes an overview, learning goals, instructional content, and hands-on activities. Sessions typically start with thought-provoking questions, and contain interesting facts and Internet sources to find more information. Module One for example is entitled "From concept to consumer: Building a foundation in problem solving" and uses the history of the bicycle as one topic to illustrate the evolution of everyday products. Each six-week module contains projects that provide the context for the key learning points. These are performance driven activities for which students' learning is demonstrated by public presentations including appropriate media, written proposals and reports, product designs, solutions to real-world problems, analysis of research data, tests and quizzes. Another component to the modules is training on specific skill sets, such as how to conduct an informational interview at a business or how to develop a computer-generated presentation, all of which are embedded in the activities. These mini-lessons are designed to be used at the teacher's discretion for certain students that may not have all the prerequisite skills.

Each draft module was reviewed by the leadership team to ensure adherence to educational design principles; university teachers and subject matter experts from Ford were also utilized to confirm the accuracy of technical content. The modules were then reviewed by former FAMS teachers to get their initial reactions on the appropriateness for high school students. A second draft was field-tested by at least two teachers who evaluated the time allocated to the activities in the module, the effectiveness of the teaching/learning process, the reactions of the students to these processes, and the suitability of the suggested supplemental teaching materials. This process proved valuable in obtaining feedback on the pedagogical aspects of the material, especially on the instructions and timing of the activities. After appropriate revisions, copy editors reviewed the modules for the language and readability, and then a production company designed the layout and graphics.

Courses and Modules

The first two courses containing six modules were ready by the summer of 2003. A formal kickoff and training session was held by Ford and EDC for about 30 teachers and other interested parties. The training was conducted in part by some of the teachers who had tested the modules with students. They helped the prospective Ford PAS teachers with content and process ideas, the demonstration of a few of the activities, and a discussion on implementation issues. Several teachers started piloting some of the modules at their schools in the fall of 2003; many more teachers took the information back to their schools to review and plan for the following school year. A team of employees within Ford and EDC was set up to provide ongoing support and technical assistance for the teachers. A Website was also developed, for use by both teachers and students, which included, among other things, additional resources and hyperlinks to other Websites for research activities.

Table 1
Partnership for Advanced Studies Program Outline

Ford PAS Courses	Module Titles
1. Building Foundations	1. From Concept to Consumer: Building a Foundation in Problem-Solving 2. Media and Messages: Building a Foundation of Communication Skills 3. People at Work: Building a Foundation of Research Skills
2. Adapting to Change	4. Careers, Companies, and Communities 5. Closing the Environmental Loop 6. Planning for Efficiency
3. Managing and Marketing with Data	7. Planning for Business Success 8. Ensuring Quality 9. From Data to Knowledge
4. Designing for Tomorrow	10. Reverse Engineering 11. Different by Design 12. Energy in the 21st Century
5. Understanding the Global	13. The Wealth of Nations 14. Economy 15. Markets Without Borders 16. Global Citizens

The development of the other modules continued using a similar process, ensuring that courses Three and Four (Modules 7-9 and 10-12) were ready for the next school year. A complete outline of the PAS program is provided in Table 1.

State Academic Standards

One of the issues about implementing a new program is addressing the concern that some teachers and administrators have about schools meeting their state's standardized testing requirements. The specific question sometimes asked or anticipated is: How will the Ford PAS program help *my* students' performance on the state proficiency test? These tests typically measure the knowledge level of students in the core academic areas of math, science, English, and social studies. Since Michigan is the home state for Ford's World Headquarters and many assembly and manufacturing plants, the Ford PAS leadership team decided to study how the state's curriculum framework (Michigan Department of Education, 2003) is addressed by the Ford PAS program. (Certainly there is a lot of overlap between most national and state standards, but Michigan teachers are more likely to use Michigan standards as their curriculum guide).

The instructional materials were carefully reviewed, one activity at a time, to understand the learning objectives and then to identify the particular standard addressed in the activities. The product of the study was a table showing all the modules and activities, and their correlation with the Michigan curriculum standards. This document is used as a resource for teachers in the state, and as a tool to describe the Ford PAS program in meetings with prospective adopting schools. Other states are encouraged to use a similar process for their particular standards. Although this study was conducted after the curriculum was developed, rather than during the development as was the case with national standards, it was meant to show a supportive relationship between the Ford PAS program and the state guidelines for academic achievement.

Conclusions

The Ford PAS curriculum includes substantial content from the core academic areas of math, science, English, and social studies. By consciously making connections with academic subjects, this technology education program fits the definition of integrated instruction. Indeed, many of the elements of the conceptual framework for integration are embedded in the PAS courses.

The student activities are contextual and applications-based. The students learn business and engineering skills by working through projects, such as developing a tour schedule for a pop musical group, or designing a new size and shape for a soft drink bottle. Further, the activities are presented to students with a holistic view so they understand the rationale for the objective and how it relates to other subjects. The projects include all aspects of business and industry, (e.g. principles of technology, economics, marketing, and management), and are not focused solely on manufacturing production. The project method itself is a major objective: students learn how to carry out a project from the initial needs assessment to presenting the final report. In addition they learn cross-functional skills and other process-oriented skills like problem solving, teamwork, and communication.

The Ford PAS program presents schools an immediate opportunity to implement an integrated technology curriculum. Teachers can use a stock of professionally-developed and tested courses. The materials have high face validity because the development process was extremely comprehensive, including the use of national standards and subject matter experts from Ford and other professional organizations. In addition, the instructional materials can simply be downloaded from the PAS website, printed from a CD Rom, or purchased for the cost of printing. The only cost for schools is to send the teachers and other representatives to a professional development session sponsored by Ford. The modular format of the curriculum gives schools the flexibility to implement all or part of the program; one school for example is using modules 7-9 for a unit on entrepreneurship in their business program.

One question which persists regarding the design and development of Ford PAS is why a major corporation would invest their time and resources in developing a school-based curriculum. First, many firms, both large and small, recognize their civic responsibility—to give back to the community in which they do business. Often referred to as corporate citizenship or philanthropy, this curriculum development exemplifies the higher ideals often espoused by prominent corporations in the United States and around the world. There is also a strategic purpose for this initiative. The critical need for young men and women in the STEM areas—science, technology, engineering, and math—is widely recognized. Ford PAS was developed to assist in addressing these needs, not just with the recognition of the problem or need, but with a concrete tool, a program made freely available to the education community.

Such a venture is not without its areas of difficulty and concern. The Ford Motor Company was constantly made aware of the pressures upon the public school system to meet the needs of its existing constituencies. The economy places financial pressures on schools and colleges, that may struggle to maintain existing courses and programs, much less adopt new initiatives. Accountability measures dictated by federal legislation weigh heavily on public school administrators, school boards, teachers, and students. Yet, numerous studies, white papers, and research reports indicate the societal need for a highly skilled workforce to compete in the global marketplace. The Ford Partnership for Advanced Studies curriculum attempts to integrate important learning outcomes, not as a mere academic exercise, but as a partial response to the needs of young people, schools, and businesses. The implementation of the program requires a group of school professionals who understand that integrated curriculum may help students perform better in all their subjects.

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