

Linking Lean Thinking To the Classroom

As team members sat down to discuss hiring a new production employee, the conversation gradually centered on the need to determine if operations could be combined to free an existing employee to do the work. Such a discussion is routine among team members at many companies, especially those implementing lean principles. But this discussion didn't occur at a company. It took place at a Nashville, TN, high school among students who had participated in a value-stream mapping exercise as part of a new program designed to better prepare them for college, business, and roles as future leaders. Now, weeks after the exercise, as students broke into teams to discuss a new lesson on managing human resources, the talk went back to lessons learned during the mapping exercise.

Mapping is one of many activities included in the new Ford Partnership for Advanced Studies (Ford PAS), an academic program designed to link high-school classroom learning to the skills needed to succeed in college and business.

"It's a new approach," said Donna Gilley, a business teacher at Nashville's Glencliff High School. "It's more than textbooks with chapters, questions, and tests. It's applications. Students apply their knowledge to solve problems. It requires thinking, not just recall and memorization."

"It's a very project-based curriculum," explained Ilene Kantrov, director of the Center for Educational Resources and Outreach at the Education Development Center (EDC), which developed the curriculum in collaboration with the Ford Motor Company Fund. "The idea is for students to see that what they're learning in Ford PAS and in other academic courses has applications in the real world and to their interests."

The curriculum combines academic content based on national standards with realistic applications in such areas as design and product development, information systems, environmental sustainability, global economics, business planning, and marketing. The objective is to link classroom learning with the challenges students will face in college and the workplace of the future, especially in fields such as engineering, business, and management.

The Lean Pizza Factory

For instance, the [value-stream mapping](#) activity and an introduction to some basic [lean thinking](#) tools (developed with training materials and assistance from the Lean Enterprise Institute) are part of a larger unit or module called Planning for Efficiency, one of 15 modules in the Ford PAS curriculum. Planning for Efficiency activities require students to use math and analytical skills to study how companies use resources. Students use writing, speaking, and computer skills to make observations and report their conclusions.

The module's textbook begins by introducing students to efficiency as the best use of available resources -- time, material, people, and equipment -- and why efficiency is

important to businesses. Students also learn about related concepts, including waste and value.

Then students watch a video about a customer placing an order in an ice cream shop and the process that workers use to fill it. As they watch, students take notes about any resources that are wasted and the possible causes. After the video, the teacher helps students combine their observations into a table.

Subsequent chapters in the module deal more in-depth with each resource. Each chapter has an activity that reinforces the lessons. For instance, in the chapter on materials and machines, the activity is the Airplane Game, a simulation -- familiar to many Lean Thinkers -- that uses the simple process of folding sheets of paper into airplanes to show students the differences between batch-and-queue production and once-piece flow.

The next-to-last chapter enables students to apply all that they have learned about efficiency in an activity called The Lean Pizza Factory. Students read about Penelope's Pizza, a small business that supplies stores with three varieties of frozen gourmet pizzas. Penelope's is fairly successful but has problems responding to changes in customer demand, which leads to scheduling problems, overproduction, and missed shipments.

Assuming the roles and responsibilities of customers and employees, students simulate Penelope's production operations. A teachers' guidebook for the module provides instructions on how to prepare materials and run the activity in the classroom. After a "production shift," students are introduced to value-stream mapping to analyze the pizza value stream and make improvements. Teams of students draw current-state maps then develop their ideas for a more efficient production line by drawing future-state maps. Each team presents its future-state map to the class. During the mapping activity, students learn about the thinking behind such concepts as takt time, supermarkets, kanban, batch sizes, and combining operations.

The last chapter in the module is the culmination of a project that students began working on during the first chapter. Titled "Mission: Efficient," the project called for students to learn firsthand how a local company tried to be efficient. Students selected a company and analyzed how efficiently managers used time, materials, machines and people. Students must visit the company at least once (three visits are recommended) to discuss efficiency with a company representative and observe the workplace. Finally, working in teams, students prepare and present their analysis to the class and the company representative.

Skill Development

Activities and projects in other Ford PAS modules include helping a food chain expand its product line through a partnership with a foreign company, creating a business plan, designing market surveys and analyzing results, conducting a break-even analysis, using statistics to make business decisions, analyzing consumer information to make marketing decisions, and designing an energy plan using renewable sources for a school building.

“It’s application-focused and correlated to academic standards to develop students’ problem solving, critical thinking, teamwork, and communications skills,” said Kantrov. “These are usually not part of the traditional high school academic program, yet both colleges and employers continually say students should have these skills. We’ve combined the academic curriculum with these skills, and that’s something unique.”

The need for a unique approach to teaching and learning in high school is becoming acute due to several disturbing trends, according to EDC:

- For every 100 students entering 9th grade, 67 finish high school in four years, 38 enroll in college, 26 return the fall after their freshman year, and only 18 complete their degree within six years.¹
- One in three 12th grade students scores below basic levels on national assessments.²
- One in three college freshmen takes at least one remedial reading, writing, or math course.³
- Reading and math achievement for 17-year-old African American and Hispanic students is the same as that of 13-year-old white students.⁴

As a result, many students lack the knowledge and skills to succeed in a changing, modern economy, disadvantaged students fall further behind, and employers aren’t able to hire the skilled, diverse workforce they need.

National reports on the problem, including one in 1999 by the U.S. Department of Education, concluded that high schools could improve students’ chances for success in colleges and careers by giving them challenging academic courses, helping them build problem-solving and team skills, and extending learning to the world of work.

Business Involvement

Ford kept these objectives in mind when it came time to update the curriculum of its Ford Academy of Manufacturing Sciences (FAMS) program. The successor to FAMS is the Ford PAS curriculum, launched in 2004 and built around three elements:

- Academic knowledge in math, science, social studies, and English.
- Interpersonal skills in problem solving, critical thinking, teamwork, business communication, personal management, and lifelong learning.
- Business and technology concepts in finance, marketing, quality, information systems, design and engineering, energy use, product development, workforce history, planning, the global economy, the environment, and efficiency including lean and six sigma.

¹ National Governors Association (2003). *Ready for Tomorrow: Helping All Students Achieve Secondary and Postsecondary Success. A Guide for Governors*. P. 3.

² Harvey, J., and N. Housman (2004). *Crisis or Possibility? Conversations about the American High School*. Washington, DC.: National High School Alliance. P. 10.

³ National Governors Association (2003). *Ready for Tomorrow*. P. 4.

⁴ Harvey, J., and N. Housman (2004). *Crisis or Possibility?* P. 10.

EDC and Ford note that the College Board, administrators of the Advanced Placement program and the Scholastic Achievement Tests (SATs), endorsed the curriculum. Local school districts assign credits to Ford PAS courses.

The complete program, consisting of five semester-long courses, was designed to be taught over two-and-a-half years in the 10th, 11th, and 12th grades as electives within the regular school curriculum. Each course consists of three six-week modules. Five of the modules were designed so they can be used independently as units in existing courses about U.S. history, statistics, engineering, physics, and economics, respectively. This gives school districts the flexibility to offer part of Ford PAS or test it without implementing the entire program. Here’s an overview of the curriculum:

Ford Pas Course	Module Titles	Grade Level	Related Academic Areas
Course 1: Building Foundations	1. From Concept to Consumer: Building a Foundation in Problem Solving. 2. Media and Messages: Building a Foundation of Communication 3. Skills. People at Work: Building a Foundation of Research Skills	10 th Second semester	<ul style="list-style-type: none"> • English • Social Studies • Business
Course 2: Adapting to Change	4. Careers, Companies, and Communities 5. Closing the Environmental Loop 6. Planning for Efficiency	11 th First semester	<ul style="list-style-type: none"> • Social Studies • Business
Course 3: Managing and Marketing with Data	7. Planning for Business Success 8. Ensuring Quality 9. From Data to Knowledge	11 th Second semester	<ul style="list-style-type: none"> • Math • Technology • Business
Course 4: Designing for Tomorrow	10. Reverse Engineering 11. Different by Design 12. Energy for the Future	12 th First semester	<ul style="list-style-type: none"> • Technology • Science • Engineering • Business
Course 5: Understanding a Global Economy	13. The Wealth of Nations 14. Markets Without Borders 15. Global Citizens	12 th Second semester	<ul style="list-style-type: none"> • Social Studies • Economics • Business

Although academic in nature, the curriculum -- with its various activities and projects -- is designed to interest students by showing them the connections between schoolwork, careers, and their budding personal interests. The curriculum presents math, engineering, and other academic subjects “in ways that are important to students,” said Cheryl Carrier, Ford PAS Manager, Ford Motor Company Fund. “They learn about different concepts and different career possibilities that they may never be exposed to until they get into college.”

So, instead of being bored with math, students will apply it in a real-world project that will hopefully make them think, “Wow, engineering is really cool,” said Carrier. “If the

United States is going to remain competitive, we must excite and engage students in the fields of math, science, engineering and technology.”

Ford PAS engages more than students. Each Ford PAS high school forms an advisory council comprised of parents, teachers, administrators, students, and representatives from area businesses, community organizations, and colleges. Business and higher education council members provide the partner high school with additional resources, such as guest speakers, tutors, career mentors, summer internships, access to technology, and tours of worksites and campuses. (Learn how businesses can participate in Ford PAS through a [Business/Education Advisory Council](#).)

“There’s great content and expertise in the private sector world with science, technology, engineering and mathematics,” said Vivian Guilfooy, a senior vice president at EDC. “Ford PAS connects students with people in the community who share their ideas, keep students engaged and show them that what they are learning in class is relevant now and in their future careers.”

Carrier said the program is in about 80 city and suburban school districts. A few colleges are using modules as part of remedial education courses for freshmen. Ford PAS makes materials available at cost to schools. Whenever possible, materials are designed for reuse to further control costs.

A third-party evaluator, the CNA Corporation, will assess the effectiveness of the program. Formerly the Center for Naval Analyses, CNA is a nonprofit specializing in operations analysis through direct observation.

But in Nashville, the verdict is already in. “It’s very effective,” said Gilley, the business teacher. “The students like it. Sometimes there is hesitation in the kids because it’s new territory; it’s outside their comfort zone. But once they get into it, the excitement level is amazing. They feel like they are in a real live company.”

For More Information

[The Ford Partnership for Advanced Studies](#) (Ford PAS)

Ford PAS provides high school students with high-quality interdisciplinary learning experiences that challenge them academically and develop their problem-solving, critical thinking, and communication skills. By building strong local partnerships with business and higher education, Ford PAS encourages and prepares students for success in college and professional careers in fields such as business, engineering, and technology. For more information about getting involved in the program visit <http://www.fordpas.org/beac/Default.asp> , send an email to FordPAS@edc.org, or call 888-338-3267.

[Education Development Center](#), Inc (EDC)

EDC builds bridges among research, policy, and practice. Its award-winning programs and products, developed in collaboration with partners around the globe, consistently

advance learning and healthy development for individuals of all ages. Today, EDC manages 335 projects in 50 countries, including early child development, K-12 education, health promotion, workforce preparation, community development, learning technologies, basic and adult education, institutional reform, and social justice.

[Workshops](#) and [Workbooks](#)

The Lean Enterprise Institute (LEI) runs monthly regional workshops on basic and more advanced lean tools. LEI workbooks and training materials - all designed to de-mystify what a sensei does - show you what steps to take on Monday morning to implement lean concepts. Visit the LEI web site for resources supporting lean transformations.

Glossary

(Adapted from the [Lean Lexicon](#))

Lean Thinking

A five-step thought process proposed by James Womack and Dan Jones in [Lean Thinking](#) to guide managers through a lean transformation. The five principles are:

1. Specify value from the standpoint of the end customer by product family.
2. Identify all the steps in the value stream for each product family, eliminating whenever possible those steps that do not create value.
3. Make the value-creating steps occur in tight sequence so the product will flow smoothly toward the customer.
4. As flow is introduced, let customers pull value from the next upstream activity.
5. As value is specified, value streams are identified, wasted steps are removed, and flow and pull are introduced, begin the process again and continue it until a state of perfection is reached in which perfect value is created with no waste.

Value Stream

All of the actions, both value-creating and nonvalue-creating, required to bring a product from concept to launch and from order to delivery. These include actions to process information from the customer and actions to transform the product on its way to the customer.

Value-Stream Mapping

A simple diagram of every step involved in the material and information flows needed to bring a product from order to delivery. Value-stream maps can be drawn for different points in time as a way to raise consciousness about opportunities for improvement. A current-state map follows a product's path from order to delivery to determine the current conditions. A future-state map deploys the opportunities for improvement identified in the current-state map to achieve a higher level of performance. In some cases, it may be appropriate to draw an ideal-state map showing the opportunities for improvement by employing all known lean methods including right-sized tools and value stream compression.