A Manufacturing Initiative – Preliminary Draft

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Revised October 30, 2014

The Manufacturing Problem

In a rapidly increasing tendency, manufactured products are being produced by companies that optimize competitive advantage by means of a number of negative factors, including lower costs for labor, minimal or non-existent health care and disregard for long term environmental damage. These advantages have tended to divert the flow of investment towards an economy of exploitation, further leveraging the market in favor of these methods.

The decrease in manufacturing outside of these competitively advantageous techniques has resulted in a corresponding decrease in employment opportunity. Highly automated equipment has decreased the availability of adequately salaried lower level jobs. The cost of education for higher level jobs, particularly manufacturing related jobs, requires students to invest an amount that often exceeds the cost of a house, while qualifying diplomas are offering diminishing chances that the student's investment of time and money in education will offer a justifiable return. An increasing number of graduates are finding work outside of their field of study. For students coming from low to middle income families, the cost of higher education can be prohibitive even with substantial assistance. The risk of inability to repay student loans compounds the problem of investing in education for these students, as lack of opportunity may preclude their ability to relieve their burden of debt by the time they must assist with their own children's education. Moreover, increasing levels of debt decrease disposable income across the board. Fewer products are purchased, downsizing production volume and exacerbating the manufacturing problem.

Reversal

This document suggests a plan for substantially reversing the manufacturing problem. The plan includes measures that need to be taken in education, automated manufacturing and investment. Individually applied measures may have some value, but a comprehensively applied solution is more likely to succeed. For example, while an increase in the use of automation can make products more cost competitive for those who may be socially conscious, similar equipment can also be purchased by companies and organizations that have little or no regard outside of profitability. Thus advances in automation technology alone might provide a temporary competitive advantage, but have little long term effect. This monologue explains how changes in automation technology, education and investment opportunity can be applied together to reinforce advantages that can be gained in each individual field, while being mutually beneficial to manufacturers, employees, their consumers and the society within which they function.

Who or What Constitutes an Initiative

This plan suggests that coordinated, mutually reinforcing actions need to be taken in areas of technology, education and investment. The plan is called an "initiative" in the sense that it can be reasonably asserted, but since it addresses a rapidly emerging problem it may not have been tried before, at least to the extent necessary to bring about a definitive outcome. This plan only outlines the necessary actions, leaving the source of implementation open to government, educational system, organization or individual with sufficient capability to influence the amount of coordination that the plan proposes.

A Problem with Automation

Prior to the Industrial Revolution, young people basically learned how to provide for themselves and their families through agriculture and the trades. A young person would learn a skill, and when sufficiently skillful he or she would use that skill to meet a need, either for one's self or for others. Through industrialization, however, more inexpensively and efficiently produced products met a variety of needs, and it became more commonplace for young people to seek employment within organizations that had the financial capacity to purchase the emerging technology and its machinery. Educational institutions, in turn, shifted their focus to teach skills required by larger organizations, and tradesmen activity diminished as trade practice migrated towards providing things or services that could not be more suitably supplied by larger companies. In the mean time, corporate ownership of organizations by second or third party capital firms tended to make profitability an almost exclusive criterion for operation, diminishing both wages and product quality to meet this end. Profits were optimized by decreasing the cost of quality and decreasing wages and environmental concern to the extent that it was possible. Fair market competition mitigated this decline to some degree, but the efficiency made possible by machinery moved the market arena towards competition between large organizations that could afford the capital equipment that was necessary to compete. In recent times, as even large organizations are becoming acquired by yet larger holding firms, and optimizing is becoming more commonplace, the negative effect of this tendency on the employee, the environment and the quality of products is becoming more pronounced. Thus while profits have been increasing, gainful employment and the quality of manufactured goods are diminishing, not to mention the environmental damage that is occurring in areas of the world where financial stress overwhelms the ability to limit it by law.

I believe that it is important to note that the negative effect that automation had on employment and product quality has relatively less to do with replacing man with a machine, as was commonly perceived especially in the 60's. Instead, it has relatively more to do with a social system that is subject to a cycle of efficiency and returns. The greater efficiencies possible through computer aided manufacturing have accelerated this process in recent years.

The Cost of Capital

Generally speaking, company profits can be increased by minimizing employee support to the extent that can be tolerated by its workers, optimizing manufacturing throughput at the expense of the environment and minimizing the cost of quality to the point that the market will stand. However, the advantages gained by these negative influences can be diminished when their weight of importance becomes less and less significant when compared with the increasing benefit of automated techniques. Thus it is increasingly possible to diminish tendencies leading to exploitation by reducing the cost of automated equipment. Movement in this direction in the manufacturing sector can be viably accomplished by means of education in automated techniques and a revised investment model.

Teaching Manufacturing as a Trade

Much of the mechanization that was implemented in manufacturing during and subsequent to WW II existed hundreds of years earlier, but was only thought to be useful in clocks, music boxes, organs and toys. The air sensing mechanism in the player piano, introduced in the 19th century, was advanced enough to control the automatic cutting and forming of parts for industry, and yet punched tape was not used to sequentially control manufacturing equipment for years after it was first used to make music. Similarly today, computers have the capacity to activate and monitor mechanisms, and to control motorized forming tools over complex paths, yet computers are underutilized in this capacity outside of very expensive capital equipment. With the emergence of more generally acquired computer literacy and low cost components, it is increasingly feasible to design and build ordinarily expensive automated machinery using the resources available in most vocational school shops.

Industrial arts has nearly disappeared from the general education curriculum. With less exposure to how things are made, a young person today is less likely to kindle an interest in manufacturing, not to mention foresee the thrill of accomplishing much good automatically. But even if the interest was generated, designing automated machinery generally needs to be pursued with a college degree in engineering, and hopes of being employed by a company that is large enough to either manufacture or invest in costly equipment. Though there is much value in advanced education, however, there also exists a large and increasing number of manufacturing opportunities that can be economically automated using skills that can be taught and economically implemented at the vocational school level.

The Necessity for an Initiative

In 1984 I invented and produced a device that successfully enabled persons paralyzed below the neck to be gainfully employed using the original IBM PC (US Patent No. US4746913). I immediately outfitted three injured individuals, who were then able to work from home. One was still using the system to manage his floor finishing business until he passed away two years ago. The entire system, including computer, key entry device and specialized hands free telephone dialing and switch hook control, cost about $8500 (in 1984 the computer alone cost about $5000). Though it cost less than a motorized wheelchair, and less than the amount of tax revenue it generated in a year, it did not enter into widespread use. Prior to their disability, these men already had jobs and substantial support from family and coworkers. Most families of severely spinal cord injured persons are financially devastated by the accident. An attendant is needed to care for basic needs. Assistance from the attendant was not continual, but an attendant needed to be present at all times. Attendants typically do not earn high salaries, but high enough to overstress a family budget. Families that could not afford attendants needed to apply for public funding. Consequently, the technology that I had invented was not enough. Once a disabled person started to earn income, he was subject to lose the public services that he relied upon to live. You could sell an injured person on the idea that his earning capacity could be restored, but not if doing so would eliminate the support that he needed. At the time an initiative was needed to provide a social framework from which a disabled person and his attendant could work together in a commercial setting. Employers needed relief from the special risks involved in hiring an injured person, and employers needed a legal framework from which they could hire two people together as a team. The tax revenue generated by the productivity of the disabled person combined with the additional productive value of a more fully utilized attendant could have easily paid for any tax concessions that would have made employment of severely injured persons attractive and coveted – but an initiative would have had to be made. (Instead, at the time the Americans for Disabilities Act was passed, giving disabled persons an avenue to sue prospective employers that did not make reasonable accommodations. Employers responded by modifying job descriptions so that they couldn't possibly be reasonably accommodated to severely disabled persons.)

Similarly feasible only with the aid of an initiative, it is technically possible now to graduate students with their own manufacturing jobs. Graduating students with their own jobs is not a revolutionary concept. Students graduating from trade schools almost immediately practice their trade, often but not always starting as an apprentice. Some students, for example, pay for their education by painting houses. A need is met, and money is exchanged. A student that first learns how to make jewelry and then proceeds to sell the craft exemplifies how this concept extends to manufacturing. It is the core concept of small business. With products that are mass produced the need for a partnership that engages a diversity of skills is more immediately necessary. This initiative proposes that there exists a great range of products that can be mass produced using inexpensive resources, that methods for mass production can be taught and mastered as a trade, and that a framework can be developed from which small manufacturing partnerships can be launched.

Corporate Ownership

As mentioned, implementing the efficiencies of capital equipment is often cost-prohibitive outside of the collective wealth available from corporate ownership, and a problem arises when investors become isolated from socially significant aspects of the enterprise, such as worker satisfaction, environmental impact and product quality. Layers of ownership introduced by investment firms make virtually all aspects of enterprise opaque except for profit. The success of this initiative presumes and depends upon the existence of investors who do not disregard the necessity for profit, but desire the freedom to weigh importance to the people whom they are investing in, the product that they are producing and the population whom they are serving. This initiative also suggests that a well connected investment community could realize symbiotic advantages that could overtake the existing trend to minimize the value of these things against the importance of profitability.

A Concrete Example

In a concrete example, consider an enterprise that specializes in manufacturing custom stair risers. (A stair riser is the vertical piece perpendicular to each stair step in houses). The market would consist mainly of builders and architects, who would offer new home buyers the option to include decorative risers at a cost slightly more than the bare planks that are ordinarily used. Automatic machinery would be designed to accept a stack of precut riser planks, engrave each riser with a decorative pattern, and unload the processed risers in a receptacle from which they can be conveniently transferred either to finishing or packaging stations. Automation limits the cost of labor for custom risers to an amount nominally higher than plain ones, thus making them an attractive option. Precut planks can be purchased from a lumber yard, so the equipment needed in addition to the automated engraving machine can be minimal. The cost for materials to make the automatic equipment, including computerized controls for three dimensional shaping, can be easily kept substantially below $30,000, and the technology to design it can be taught at a high school level. The completed operation would need components common to most small businesses: work space, a financial system, and sales. One or two technical people, someone educated in cost accounting and a sales person would be sufficient to start this business. Each will need the ambition to learn something of the other's specialty, as well as the willingness to participate in the more mundane aspects of running a business. I believe that such ambition and willingness would not be hard to find.

Projects like this could be launched for substantially less than the cost of a college education. This initiative proposes that it can be done in an educational setting, and that the starting capital can be raised from a segment of the private sector who recognize the necessity for profit, but who are also inclined to weigh the importance of those whom they are investing in, the product that they are producing and the population that they are serving. It may be first of all attractive to family members, but it is especially attractive to those who are motivated to use their wealth to invest in developing the potential of underprivileged youth. With more than money at stake, these investors are more likely to further contribute resources to both the students and their educators, such as meaningful contacts and expertise, in an effort to help the endeavor to become self supporting and profitable. They will be also be less inclined to divest at an inopportune time, contributing to the stability of the enterprise

Education

More often than not, educators are overburdened by the day to day demands of their profession. It is unrealistic to expect educators to become immediately versed in automation. Their professional knowledge is essential, but they will need to gain much of their experience in manufacturing and automation together with their students. As the initiative matures, educators will become more universally familiar with existing technologies, and more able to provide specific guidance to their students' entrepreneurial ventures. Instructors and students will learn new material together with every initiative, and also contribute to advancing the state of the art.

Technical instructors must be competent in the industrial arts, including machine shop practices, documentation and manufacturing process control. Together with the students, teachers can gain a great wealth of knowledge that is freely available from component sales engineers and manufacturer's representatives, who are not only knowledgeable in automation technology, but also effectively able to lecture on the theory of operation and how it can be specifically applied to the students' venture. For example, a manufacturer's representative for hydraulic cylinders would typically be adept and prepared to explain the physics behind differing demands of force, mechanical advantage and speed. He or she may interject reasons why the company's product may be chosen over others, but more significant to the salesperson, equipment designers tend to choose components that they are familiar with. Thus there is sufficient justification to deliver a quality presentation free of charge.

Technical instructors need to limit mathematical and scientific material to that which applies to the types of automation that can be incorporated in the initiative. Likewise, business instructors will need to scale the complexity of the material that they teach to an extent that can be managed by the team of students. The initiative will move a theoretical business plan into the real world of concrete responsibility, requiring clearly defined objectives that can be measured, adjusted as necessary, and even abandoned under certain circumstances.

Basic technical instruction must be scaled to meet the need. For example, while mechanical engineering students apply higher level mathematics in the study of material science, a tradesman in automation may only need to be taught the concepts of stress, strain, stiffness etc. as they apply to the materials that are commonly purchased to build automated machinery. A trade student would need to be exposed to materials and components that are common to his trade, while an engineering student usually gains this type of knowledge on the job after graduation. Most of the installations of automatic machinery that I have assisted with (in the twenty five years that I have done this through Ability Systems Corporation) have been designed by persons who have a feel for the trade, outside of sophisticated theory, and with a measured amount of electronic coaching similar in extent to the material found in the "CNC Video Instruction" series on www.abilitysystems.com.

Action Items

Curriculum needs to be written for teaching manufacturing as a trade. Basic courses in mathematics, business and applied science can be modified to accommodate the requirements of more specialized classes. Basic courses in business would include subjects like Accounting, Marketing and Business Planning. Basic courses in mathematics would include Geometry, Algebra and Trigonometry, with a heavy emphasis on interpreting graphs, tables and charts. Basic courses in applied science would include electricity, computers and material science.

More specialized classes need to be designed that apply these basics to a small manufacturing operation. Business classes would concentrate on things such as cost accounting, process control, and low cost alternative marketing strategies. Mathematics would be applied to problems relating to machines, manufacturing, machine and product design, and make-or-buy decision making. Students must learn to interpret literature that is used to select and size commercially available components. A course on motors and actuators, for example, would enable the student to competently size and select these components. Some sessions of these specialized classes can be outlined by the instructor but taught by manufacturers' representatives.

A limited amount of instruction in computer programming would be extremely helpful. Fundamental concepts of computerized sequencing, decision making and repetitive operation are easily taught and grasped. Basic concepts undergirding the use of CAD (Computer Aided Design) and CAM (Computer Aided Manufacturing) will provide a basis for selecting and using computerized methods that are increasingly relevant to automated machinery. Curriculum needs to be written that extends the correlation between representative geometry and the manufactured part (usually taught in drafting courses) to the computerized manipulation of machines to attain an automated result. The increased technical literacy and exposure to graphical applications among young people today has made this necessary objective attainable at the vocational school level.

A major framework of operation must be developed from which the students can progress to the final stage of their formal education, which would entail actually launching a business enterprise. The framework would need to take into account mutual dependencies that exist between all of the participants. The framework must define the role and responsibilities of the students as well as the expectations of their investors. It must prescribe contingent courses of action for success and failure, as well as unexpected circumstances such as a key member's inability continue with the company. It must define the distribution of control between the students and their investors, and chart a course for ownership by the students if that is what they desire. A major framework, in turn, can be used to provide guidelines out of which more detailed frameworks for specific projects can be developed.