

# A Scenario for the U.S. Manufacturing Sector, circa 2040

By  
Tomas B. Carson

Consume my heart away; sick with desire  
And fastened to a dying animal  
It knows not what it is; and gather me  
Into the artifice of eternity.  
Once out of nature I shall never take  
My bodily form from any natural thing,  
But such a form as Grecian goldsmiths make  
Of hammered gold and gold enameling  
To keep a drowsy Emperor awake;  
Or set upon a gold bough to sing  
To lords and ladies of Byzantium  
Of what is past, or passing, or to come.  
(W.B. Yeats, 1927)[1]

## 1. Introduction:

The subject of this scenario is the manufacturing sector in the U.S. 50 years from now, but it could hold true for any First World country. As part of this scenario, I will attempt to sketch some of the principal changes that will occur in the economy, as well as in the way work is viewed and valued, with an emphasis on some anticipated paradigm shifts. I have chosen the time frame of 50 years to give ample scope for some of the transformations we are already beginning to detect to work their way through the economy. Just as the U.S. underwent fundamental changes in the last 50 years as the result of advances in science and technology developed in the late 19th and early 20th century, so we can expect similar transformations in the next five decades, stemming from the revolutionary developments taking place in such fields as computer science, advanced communications and genetics. In other words, the Third Wave Alvin Toffler describes will have washed completely across the country by the year 2040.

I will not attempt to describe the difficult transition period which will occur in the intervening years, since most futurist writers concern themselves with medium-term time horizons (10 to 30 years); I will defer to such authors as Paul Taylor and Robert Reich[2] in dealing with this transitional period. Of course, many of these medium-term effects will still be felt 50 years from now and I will touch on them later in this paper. My scenario will begin with a brief description of a typical factory circa 2040.

## 2. The Automated Factory of 2040

This installation will not be a large-scale operation since only a relatively small number of mass manufacturing facilities will still exist. Those few factories in existence will probably be located in Second and Third World countries. Of course, the terms First, Second and Third World will not exist 50 years from now, as the global economy will be in full force -- but that is another story.

Our typical plant will be a small-batch operation. It will operate 24 hours a day, all year round with only short downtime periods for major repairs and redesign of production. The plant will require only a handful of human workers, mainly in trouble-shooting roles, since routine production and maintenance services will be performed by industrial robots controlled by the plant's computers. The plant will operate with very little inventory -- either of raw materials, spare parts or finished products. The factory will be tied into an integrated computerized network covering the entire manufacturing process including design, testing, production, supervision, transportation, marketing and sales. The system will be able to predict with considerable accuracy the weekly, or even daily, demand for finished products and might, in some cases, be capable of designing new products with little or no human intervention.

Most of the basic science and technology, including the necessary computer software, already exists to bring this plant into operation, with the exception of the ability to design completely new products; but by 2040, even this obstacle may have been overcome, as computers should reach something close to human cognitive equivalency by this time.

In addition to a few trouble-shooting and designer positions in the factory proper, there will still be a role for a small core of top management personnel. They, like the captain of a large ship, would not run the plant on an operational basis but will be responsible for overall strategic planning and decision making. Equally important, they will be held responsible by the owners of the enterprise for the success of the operation. These top executives will work with a small staff of assistants, but all routine office work will long since have been fully automated. Needless to say, all personnel will be highly paid and will receive non-cash benefits, such as stock options, as incentives to achieve maximum productivity and profits.

I have not had much success in finding studies about productivity increases in fully-automated factories versus plants using conventional technology; however, Paul Kennedy cites an example of a currently functioning Japanese plant which gives some idea of the order of magnitude of productivity increases involved:

A few years ago Nissan upgraded its automobile plants in the Tokyo area with a highly sophisticated method of assembly, using robots. Formerly it took eleven months and cost Nissan 4 billion yen to retool its body assembly for a new model; now it takes a quarter the time and costs about a third as much...Perhaps the famous FANUC manufacturing plant near Mount Fuji comes closest to representing the 'factory of the future.' Before 1982, a work force of 108 people and thirty-two robots produced about 6,000 spindle motors and servo motors each month. After a radical redesign and further automation of the factory, it now employs only 60 people and has 101 robots to produce 10,000 servo motors a month, a threefold improvement which handsomely repays the initial investment. Yet even that is regarded merely as an interim step toward full automation by FANUC's management.[3]

These major increases in productivity and the increasingly lower cost of automated equipment will drive almost all manufacturers to fully automate by 2040. Productivity gains will draw many firms, both domestic and foreign, to locate or relocate their plants in the U.S. instead of in low-wage, Third World countries as is currently the fashion. Access to the market is an additional factor drawing many firms to locate or relocate in the U.S. As mass manufacturing gives way partially, or completely, to customized products made in short runs, companies wishing to compete in the highly-varied and volatile global economy will have to locate production fairly close to customers for the following reasons:

(a) Short Delivery Time

Since styles and models will change frequently, the time-lapse between design and production of a new product and its delivery to the point of sale will be critical elements for a competitive advantage. Thus, factories located near their principal markets will be in a better position to compete than plants located thousands of miles away.

(b) Import problems

By locating production facilities in the country of sale, the manufacturer avoids the risk of high import duties as well as negative effects on sale prices due to differentials in currency values of exporting and importing countries. (Japanese and German automobile manufacturers are already aware of these factors and are locating increasing numbers of plants in the lucrative U.S. market).

(c) Transportation costs

As labor becomes a marginal cost of production[4], transportation costs become an important element of competitive advantage. Once again, the plant nearest the market may have the lower

sales price. For the above reasons, conceivably more and more manufacturing plants will be located in the U.S. and other large markets. However, as stated before, the human workers in these facilities will be of limited number. In fact, it is highly likely that long before we reach the year 2040, only about 2% of the national work force will be engaged in manufacturing -- about the same percent presently engaged in agriculture and extractive industries in this country.

### 3. Effect on the Economy

A description of the manufacturing sector would not be complete without mention of possible effects of this production revolution on the economy in general

As Alvin Toffler describes in detail, the day of long production runs and standardized products is reaching its end<sup>5</sup> and will have totally expired by the year 2040. The result will be a huge variety of customized products for every conceivable taste and budget range of uniformly high quality. In reality, there should be little real difference between the products sold at the Walmarts of 2040 and those at the Saks Fifth Avenues, except for certain design features and richer-appearing materials which will justify the higher prices charged in up-scale stores.

When we consider the impact on the economy of the revolutionary advances presently taking place in science and technology, it is reasonable to believe that the average production costs of goods (manufactured and agricultural products will have considerably decreased by 2040: I would venture to guess in the range of 60% to 80% over today's costs. Sales prices should drop by a corresponding amount since the entire world will be tied together in a global market with heavy competition between producers.

Lest I be accused of crystal-ball gazing in making these predictions, I would like to digress a moment to mention some of the reasoning leading me to the prediction of plummeting costs of goods worldwide.

When one analyzes the various items going into manufacturing and sales costs of a particular product, it is evident that these costs could shrink to a fraction of their present size. Take, for example, raw materials and supplies. These items will be affected by two major trends presently underway: the growing automation of production and the increasing use of inexpensive synthetic materials (some of which, in the future, will be produced by revolutionary genetic techniques still in the early experimental stage). Another major manufacturing cost is labor, which, as I mentioned before, will be drastically reduced by 2040. Transportation and energy costs will also be cut substantially when plants locate closer to their markets and when synthetic and more fuel-efficient products replace traditional energy sources. Finally, overhead and sales expenses will decrease substantially as office and general overhead costs benefit from automation. The only

major item that may still constitute a major expense is depreciation (which reflects the purchase price of machinery and equipment), but even this cost should substantially decrease along with the projected lowering of costs in computer power.

#### 4. Impacts on Society

One of the principal impacts on society from the coming developments in manufacturing has already been discussed in the previous paragraphs: the expected huge increase in the variety of goods on the market and a corresponding decrease in prices. Another major impact has also been mentioned: the virtual elimination of jobs in the manufacturing sector, except for those involving fairly high-level skills. Robert Reich in his recent book, *The Work of Nations*, calls persons possessing such skills 'symbolic analysts.' He argues that these well-educated workers are prospering, as a huge integrated world market rewards them handsomely; whereas the least-skilled workers are growing poorer, losing out to similarly unskilled workers in the Third World. Reich calls for a national recommitment to the productivity and competitiveness of all the nation's citizens[7].

The jobs of the surviving industrial workers in the coming decades will command relatively high wages; but what will happen to those unable or unwilling to compete in this limited job market? For such persons there will be a number of options besides permanent unemployment. Some symbolic analysts may choose part-time employment (including job sharing) or highly paid but sporadic work as consultants (there should be a high demand for such people). Others may prefer long vacations or 'sabbaticals' of six months or more. More typically, there will be the option of very early retirement with a substantial pension or, for the truly entrepreneurial, the option of starting one's own business.

For those who cannot make it into the ranks of symbolic analysts there will also be a number of recourses besides idleness. There will be a plethora of new jobs in the service sector. Many of these jobs will be for skilled technicians as well as for college graduates. Many of these service sector jobs will command good wages since the workers will be using highly sophisticated and delicate equipment. In fact, we may have to completely redefine what we mean by services, since many jobs will be in fields just beginning to develop, such as bioengineering. 'Caring' professions will undergo great expansion, especially work with the elderly whose ranks will increase substantially due to advances in medical sciences. Another will be in training and education, not necessarily as traditional teachers (much of the routine pedagogical work will be done by computers), but as guides, coaches, and in the case of young children, caretakers [8].

At the same time, there will be increasing options in what are now called 'volunteer' services. Very little has been written from an economic standpoint on the importance to the national

economy of such work, although Peter Drucker has dealt with the subject in recent books[9]. This public service work will, in some cases, be remunerated by in-kind payments, such as food stamps, and by certain special benefits such as low-cost student loans or even (under the new national health-care program) access to procedures not normally covered by medical insurance.

Just as there are many descendants of people unable to adjust to Second Wave conditions who now inhabit the urban ghettos of this country, there will be a considerable number of people who cannot make the transition to the Third Wave economy that will dominate by the year 2040. The whole subject of what to do for such persons, 'the permanent underclass,' as some writers call them, goes far beyond the scope of this paper. Nevertheless, I predict that long before the year 2040, this issue will become a matter of the highest national priority, much as the search for the cures for cancer and AIDS are today. I confess I have no pat answers, even though I have spent some 25 years working for the economic and social development of the poor in Latin America. I suspect Lawrence Harrison is right when he claims that only by changing the values and attitudes embedded in a particular culture can we truly attack the problem of underdevelopment;[10] but how this can be done politically, I have no idea. Hopefully, the development experts of the future will find a way, and there will be great societal pressure on them to do so.

## 5. Paradigm Shifts and Human Values

So far, I have painted a fairly rosy picture for most workers in America 50 years hence. There is a darker side to this scenario, above and beyond the plight of the 'permanent underclass' and that lies in aspects studied by social psychologists, since it deals with how people view themselves.

It is worth noting that the shift in the nature of work we have been discussing involves a real paradigm shift in the way work is viewed and valued.

As any basic textbook in social psychology tells us, people tend to invest a great deal of emotional energy in having and holding a job. Losing or changing one's job is ranked as one of the highest stress factors, along with divorce. Also, we in the United States tend to view our job and its status (or lack of it) as a defining aspect of our personality and the structures and discipline of work as a necessary part of our lifestyles [11]. The loss, maybe permanent loss, of a traditional wage-earning job can be a traumatic experience, from which some people never recover. The real possibility that the manufacturing sector in the U.S. will require fewer and fewer workers, to reach a situation (long before 2040) analogous to that of the agricultural sector today, will be a devastating event not only economically, but also psychologically, for many people. Of course, for those able to adjust to the new economy, these changes we have been discussing could be liberating; but for many the transition will be painful and will give rise to increases in mental illness and all sorts of self-destructive and antisocial behavior. As I stated

before, dealing with these factors will become one of the highest national priorities, not only in the U.S., but throughout the world.

What are the major roles that value issues can play in this situation? To answer this question, I will take an indirect approach. Abraham Maslow, the founder of the school of humanistic psychology, analyzes human motivation and personality in terms of a hierarchy of needs ranging from the most basic to what he calls the meta, or growth needs[12]. They are in ascending order: Physiological (hunger, thirst, sex, sleep, etc.); Safety-related (shelter, protection from danger, etc.); Social (love and affection, friendships, etc.); Self-esteem related (self-confidence, status, personal recognition), and finally, Self-actualization (realizing one's potential, self-development activities, behaving creatively, problem-centered orientation to life, identifying with the problems of humanity, acceptance of self and others) [13]. The first four basic needs in the hierarchy are dominant in most civilizations. Only when basic needs are satisfied is the individual free to pursue the satisfaction of growth needs. The city-state of Athens around the 5th Century B.C. is one of the only western civilizations where meta-needs were foremost for a long period of time. Even then, meta-needs were of importance only to male citizens (the routine work was done by slaves and women, so free males could indulge in more 'elegant' pursuits, unfortunately including war). Could this dream of self-actualization for most people come true in our civilization in the next 50 years? If so, what fundamental changes in values and beliefs will we face? Many writers on utopia have speculated on this question (not the least of which is Karl Marx). I will not attempt any such thing in this paper. However, if some of the developments I discuss here actually occur, we will be forced to reexamine our fundamental beliefs about the dignity of work, the worth of the individual to society, the basis of one's self-esteem and other concepts lying at the core of our Judeo-Christian value system.

In addition to these considerations, we may also be facing an even more fundamental shift of thinking related to the nature of humans and our relation to machines. I can only hint at this subject, since it far exceeds the scope of this paper; however, in essence, it deals with a possible further evolutionary development of the human species. Many writers have discussed this possibility: notably Buckminster Fuller and the philosopher-scientist, Pierre Teilhard de Chardin [14]. Recently, I read a book by a young biophysicist, Gregory Stock, which deals with just such questions[15]. Among other things, he argues that our increasing reliance on new technologies join us inextricably to machines in a kind of symbiosis. At the same time it binds humanity together to form a new global creature he calls 'Metaman.' What this means in terms of human values is still unclear, but what is fairly evident is that, as Peter Drucker writes:

Every few hundred years in Western history there occurs a sharp transformation... within a few short decades, society rearranges itself...its worldview; its basic values; its social and political structure; its arts; its key institutions. Fifty years later, there is a new world. And the people born

then cannot even imagine the world in which their grandparents lived and into which their own parents were born. We are currently living through just such a transformation.[16]

#### NOTE

1. From "Sailing to Byzantium," *The Poems of W.B. Yeats* (New York, The Heritage Press, 1970).\par

2. Alvin Toffler, *The Third Wave* (New York, Bantam Books, 1981).

3. Paul Kennedy, *Preparing for the Twenty-First Century* (New York, Random House, 1993); Robert Reich, *The Work of Nations* (New York, Alfred A. Knopf, 1991).

4 Gregory Stock, *Metaman, The Merging of Humans and Machines* (New York, Simon and Schuster, 1993), pp. 55-60.

5 Kennedy, *op.cit.*, pg. 88.

6 "Today virtually every U.S. Manufacturer uses less labor; 25 years ago labor accounted for as much as 40 percent of production costs while today it is often closer to 5 percent." From *Focus*, National Center for Manufacturing Sciences, Ann Arbor, Mich., September 1993.

7 See class lecture notes.

8 Toffler, *op.cit.* Ch. 15.

9 See Class lecture notes

10 Hans Moravec, *Mind Children* (Cambridge, MA., Harvard University Press, 1988) pp. 65-68, A-2.

11 Reich, *op.cit.*

12 Peter F. Drucker, *Post-Capitalist Society* (New York, Harper Business, 1993), pp 38, 40-42, 41n. 136.

13 Drucker, *op.cit.*

14 Lawrence E. Harrison, *Underdevelopment is a State of Mind* (Lanham, MD., Madison Books, 1985).

15 Toffler, *op.cit.*, pp. 243, 279, 385-89.

16 Abraham Maslow, *Toward a Psychology of Being*, (Princeton, NJ, Van Nostrand, 1962).

17 *Ibid.*

18 R. Buckminster Fuller, *Critical Path* (New York, St. Martin's Press, 1981) and Pierre Teilhard de Chardin, *The Future of Man* (New York, Harper and Row, 1964). 19 Stock, *op.cit.*

20 Drucker, *Post-Capitalist Society*, p.1.