A Look into the Future: The U.S. Baking Industry in the 21st Century

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The only truism about the future that one can accept was a remark made by Abraham Lincoln almost 150 years ago. “The best thing about the future is that it comes one day at a time…” Syndicated columnist George Will more recently reminded us why we are so unprepared for what lies ahead when he said, “The future has a way of arriving unannounced.”

When attempting to envision the future industrial climate of baking, most pragmatic forecasts are usually counter productive. They tend to be linear in a world that is rapidly becoming multidimensional. A true understanding of the future lies somewhere between Lincoln’s and Will’s perspectives. Success lies in understanding the interrelationship between anticipation and knowledge; anticipation fosters foresight while knowledge creates insight.

This page is usually reserved for minds far greater than my own. I am neither a scientist nor food technologist. What I do offer is insight into the trends and activities of the United States baking industry from some of the brightest minds that make up our industry. This article is not intended to cover in detail all emerging manufacturing technologies impacting baking but to illustrate the dynamics that are at play and your relationship as cereal chemists to those issues.

Putting the Future in Perspective

To gain an understanding of the future of baking in the United States and its relationship to manufacturing technology, one should really look at the past 100 years. At the turn of the 20th century, there were approximately 10,000 commercial baking plants in the United States feeding approximately 100 million people (4). Today, there are approximately 650 plants feeding nearly 300 million people. A review of past achievements in commercial baking repeatedly demonstrates the interconnectivity of science and technology. No one can doubt the degree to which knowledge has accelerated. Look to your own achievements in cereal chemistry. Advancements in enzyme technology for breadmaking have led to extending shelf life in breads that were never imagined 20 years ago. More recently, developments have been made to provide efficiencies in dough strengthening and shorter-term softening systems. You have been working to economically reduce or replace undesirable oxidizing agents like potassium bromate and azodicarbonamide (ADA). Successful reduction in trans fat is something in which you should also be recognized. However, there are still more challenges ahead in reducing saturated fats and totally eliminating trans fats.

The focus of this article is not on science; that is your purview. What is important is what I eluded to above, the interconnectivity of science and technology and how members of the grain foods community can craft a strategy to distinguish trends and discern how they are interrelated.

Understanding Synergy

The acceleration of knowledge, both internally applied to cereal chemistry and baking as well as “fringe related” technologies are having a profound effect on what you do as a scientist and what we consume as consumers. Yet scientific advancements, like many other forms of progress, are products of a market-driven economy. To understand the direction where this synergy might be leading us we might want to know:

1) what’s baking in America and what are consumers consuming; 2) from a food science perspective, what are the compelling issues and what do we need to know to adjust our skills and interests accordingly; 3) what challenges lie head; and 4) what are the emerging manufacturing applications and what do we need to know about them.

What is America Eating

The good news is that consumers have returned bread to their table. The Atkins diet has almost completely faded, and yet, like a phoenix rising from the ashes, consumers are finding new health benefits and bakers are finding new profits to be gained from whole grains.

It is important to remember that commercial baking in the United States is a mature industry. As most bakers know, profits are counted in pennies not dollars, unlike in the oil or pharmaceutical industries. What is important to bakers is the direction of sales trends, not the spikes and valleys experienced by some high-tech industries (Table 1).

In 2005, the industry welcomed some good news (3). Fresh bread consumption was up 0.3%, frozen bread up 3.7%, a steep increase in English muffins, and a consistent increase in tortilla sales of 3.5%. These sales figures provide a very good idea of where investment dollars will continue to flow, both toward R&D in product development as well as manufacturing technologies. If you follow the profit streams, you can begin to understand the trends.

What is important to note regarding these sales figures is that they represent broad categories of products. For those not familiar with the American bakery market, not all Americans share the same tastes.

A bagel in New York City is not the same product as a bagel in Beaugart, TX. As any cereal chemist in the United States can attest, regional tastes, water, and raw ingredients are as diverse as our politics. Making a loaf of bread in Seattle is very different than in Savannah, GA and such different conditions have implications for manufacturing technologies.

Before we begin to look at emerging applications of manufacturing technology, I believe it is important to look at the larger picture of capital construction projects.
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Capital Investment Translates into Technology Enhancements

If you follow the flows of invested capital, you will get a sense of where the trends are occurring in manufacturing technology. Baking companies will invest in emerging technologies when marketing opportunities provide enhanced reasons to expand production capacity. Capital construction projects (1) increased total industrial baking capacity by 10% during 2005, the largest 1-year gain since 1991. Total capital investment for 2005 was $311,500,000. The number of projects was 70, adding almost 4 million square feet (372,000 m²) of capacity. Of that number, expansions and renovations were 41 and new plants were 29. The average expansion project size was approximately 48,000 square feet (4,500 m²) and new construction was 61,000 square feet (5,700 m²).

Capital investment in 2006 was more than double that of 2005 (2). Total investment was over $780 million, with 51 expansion projects and 30 new plant installations, adding an additional 3,107,000 square feet (289,000 m²) of industrial capacity.

How Does Investment Capital Impact Cereal Chemistry?

Marketing, distribution, food safety, and to some degree, a renewed interest in sanitation and hygiene are the reasons for the expansion. Investment in process technology is driven by marketing, cost containment, utility utilization, and manpower. All of these are critical to the work of cereal chemists, today and in the future. A brief review of the industry’s most recently constructed U.S. baking plant might provide a little insight into how a regional U.S. baking company is positioning itself for the future.

In August, United States Bakeries Corporation, Portland, OR, began operating a new $42 million facility in Eugene. The flour tanks have a capacity of 360,000 lb (164,000 kg) of white flour, 130,000 lb (59,000 kg) of wheat, and 230,000 lb (105,000 kg) of mixed grains. The ingredient batching system blends more than 15 different ingredients ranging from 50 to 125 lb (22.7–57 kg) per min. The sponge fermentation room has a bread capacity of 9,000 lb (4,100 kg) per hr, buns at 5,000 lb (2,900 kg) per hr with a 4–4.5 hr humidity rate of 80% ± 1% and a temperature at 80°F ± 1° (26.7°C).

The bread proofer capacity is 15,000 lb (6,800 kg) per hr with a proofing time of approximately 1 hr. The proofing conveyor is almost 0.5 miles (0.8 km) long. The bread tunnel oven capacity is 150 loaves of bread per min. The oven is 150 feet (50 m) long with an oven bake time of 19–20 min. At an 80% utilization rate, the oven has the ability to produce approximately 1.2 million loaves of bread per week.

The pan retrieval and storage system has a capacity of 250 stacks of pan storage spaces with six bread pan varieties and 11 bun pan varieties. The dough mixing capacity for bread equals 2,500 lb (1,040 kg) every 10 min and buns equaling 2,000 lb (910 kg) every 12 min.

The bun proofer capacity is 7,500 lb (3,410 kg) per hr with proofing time of approximately 1 hr. The proofing conveyor is almost 0.75 mile (1.2 km) long. The bun conveyor oven capacity is more than 1,200 lb (546 kg) every 10 min at an oven bake time between 7.5 and10 min. The bun cooler capacity is 16,000+ buns every 20 min with 20 min of cooling time over the 0.25 mile (0.4 km) of bun-cooling conveyor belts. The extruder bun divider capacity is 750 buns per min with a variable scaling weight of 1–6 oz (28–170 g).

It is important to remember that capital investment is what drives process technology. Without the proper ROI (return on investment), most of your work in R&D will never be fully implemented. The same applies to new equipment technology. Without the ability to increase production or reduce costs, developments in machine and process technology would also remain on the drawing board.

What Does the Future Hold?

Much of what has been shared so far should serve as a footprint for viewing future baking trends. As alluded to earlier, investment in process technology is driven by marketing, cost containment, utility utilization, and manpower. The dynamics of these four factors over the course of the next 5 years will determine the impact they will play in your role as a food technologist for the remaining part of your career.

Although I would like to take credit for such observations, the following prognostications are a collection of some of our industry’s best and brightest minds: baking in the future will be highly automated; bakeries will be fully staffed by only a few process technicians; process technicians will have minimum flexibility to make formulation changes; changes will be controlled through a central system within the bakery and accessible only by senior technicians; manufacturing lines will incorporate auto rejection technologies with tighter variances in specifications; redundant food safety systems, although expensive, will be integrated into the production processes to eliminate or minimize downtimes; and once labor costs have stabilized, energy management systems and alternative energy systems will receive constant scrutiny and priority investment considerations.

Please note that “highly” is italicized. Today we are producing faster than we were yesterday and we will be still faster tomorrow. Capital investment and ROI expectations will demand it. You, as cereal chemists, will be the creators of the science driving this transformation. If you believe that we are already pushing the limits, plan to step aside: someone will always be right behind you, willing to push the limits even further.

Our demand for industrial capacity, as well as our poor investment in education and training, will result in a workforce that is more automated and mechanically oriented instead of process oriented. Our quality management systems will no longer involve people but will instead be an integral part of the process. Consequently, the science behind the process will need to be virtually foolproof and the technology itself, 100% error free.

Quality systems will be integrated within the process. Examples include the use of near-infrared (NIR) in mixing or visual photography that examines every loaf, bun, cookie, or croissant for consistent weight, color, etc., within a closed-loop system that automatically corrects for deviations.

Viewing the Impact of Manufacturing Technology

There are six critical areas of emerging manufacturing technology that will have a profound impact on cereal chemistry: formulation and processing, freezing, ingredient handling, robotics, energy management, and food safety. A fundamental understanding of how these areas interrelate will help bakers achieve a higher level of success. Trends that impact formulation and processing will have direct impact on your required skills and competencies.

Some of the new challenges in the production of multi-grain and organic breads have already been met but more are needed. Organic, all natural, par-baked and some fully baked artisan breads have limited shelf life. There will be an effort to better preserve these more costly breads with “all natural” and “non-GMO” ingredients.

Fortification of bread items with omega-3s, as well as nutraceuticals, vitamins, and minerals, is surging. Two slices of bread, once thought to be a conveyance only for lunchmeats, will become a preferred vector for delivering vitamins, minerals and other essential nutrients.
Organic and natural breads will pose a challenge for many bakers. Material sourcing is one of many major obstacles to be overcome. The integration of such processes into mainstream production facilities will be challenging from a raw ingredient and processing management perspective, as well as a personnel training and education process. Look for separate, dedicated production lines as a minimum investment. Most likely, separate production facilities will be required. Large companies will most likely pursue these through acquisitions.

The short term will likely see new demands and applications for allergen testing and water monitoring systems. Although both may be considered as vital components of a food safety management program, some believe these steps can and should be moved further up the process stream as an integral part of the production management process.

The one emerging technology that may offer the greatest potential to satisfy future processing expectations is the use of NIR in dough make-up systems, and evaluation and control systems.

**Freezing Technology**

Sales trends suggest that interest in frozen products continues to increase. Consolidation, transportation demands, and inventory management strategies are just a few reasons why freezing technology will continue to receive interest and investment dollars over the next 10 years. Although there is no one system that can be universally applied across the baking industry to meet everyone’s needs, look for the integration or combination of multiple systems to meet both flexible production needs, energy savings, and facilities management requirements.

**Why Ingredient Handling or Robotics?**

Changes in ingredient handling systems will continue to increase operational efficiency and product consistency. Systems will become more accurate in controlling weight, metering, and batching. More importantly, systems will be integrated that will assist in preventing allergen cross contamination through ingredient and product segregation and through controlled automated conveying systems.

Robotics will continue to emerge in baking operations. Although this technology has already entered the industry in a few applications, such as pan retrieval, packaging, and palletizing, the high cost of labor and its attendant liabilities will continue to drive the search for applications for robotics. The area of greatest potential is in shipping and loading. Material handling and conveying systems now used by such organizations as Federal Express or eBay, will find their way to bakery shipping docks. As the size and scale of production facilities increase, so will investments in product and material handling. In some instances, watch for distribution alliances and copackaging production opportunities between competitors.

**Energy Management Systems**

Soaring energy costs combined with increased new product development have increased interest in and use of oven profilers. Such devices take the guesswork out of oven control and provide bakers with better quality control measures. As this technology expands, cost savings will be realized. Some bakeries are already experiencing monthly savings in the range of $4,000. In addition, such devices aid in clarifying bake time, moisture control, and quality control.

Fuel cell energy systems as well as microturbine technology will continue to be reviewed as alternative fuel sources for bakeries. Microturbine has enormous potential as a system to recapture energy from waste heat generated from ovens.

Thermal oil heat-transfer technology may continue to draw interest from U.S. baking companies as more data becomes available to support the investment equation. Depending on the design, thermal systems cost approximately $400,000 more than the traditional ovens but utilize nearly one-third less energy.

**Emerging Technologies**

Emerging areas of interest in new technology are radio frequency identification (RFID), vehicle transport, and food safety and security technology. Customers could well impose some areas, such as RFID and food safety systems, on baking companies while cost savings is driving research in the area of vehicle transportation. RFID technology provides a wealth of information and opportunities for baking companies and their customers; the most obvious is the ability to capture real-time data for inventory control and process management. Cost of implementation and RFID chip availability remain the immediate obstacles but market forces will eventually force baking companies to implement such programs.

With regard to food security, anything is possible. Technology in this area is advancing so quickly, it is difficult to single out what might be applicable across the industry. One segment that is receiving interest is in water-monitoring systems. Water-monitoring systems can detect a broad number of potential chemical contaminants that might otherwise be incorporated into the baking production process. Such systems are becoming very cost efficient and easy to incorporate into the production process.

The benefits of vehicle transport technologies, on the other hand, remain poorly defined, with numerous options and variations to be evaluated. Hybrid technologies and natural gas conversion systems are the most promising applications for direct delivery route trucks. Fuel cells and hydrogen systems are still emerging and would require significant infrastructure investments over and beyond the limits of the baking industry itself.

**Manpower—The Unpredictable Factor**

As food technologists, the greatest hurdles to success lie outside your sphere of control or influence. The human factor and the sustainability of our workforce will pose enormous challenges to your skills and competencies.

As an industry and an economy, we are failing to make significant investments in communications, education, and training. Demographically, the numbers are working against us. We have failed to capture and transfer the tacit knowledge of baking acquired by legions of post-World War II generation bakers. Corporation consolidations have shifted the current skill sets of soon-to-retire baby boomers from production to technical sales. We do not have the comprehensive education and training strategies in place necessary to meet the needs of future workers. We are moving away from an industry based on craft to one dependent upon process and control. What will emerge is a specialized workforce trained to supervise machinery over which they will have little control.

**Conclusion**

Everything that I have shared with you could have been gleaned from the headlines of the bakery trade journals or through casual debate with sales representatives and executives. What is most important is that you comprehend the dynamics that take place between these emerging technologies and the implications they will have on you, personally and professionally. We can no longer rely on simplistic one-to-one relationships—interdependency is becoming more multidimensional. As the industry moves to higher levels of productivity and technology, we need to capture and retain tacit and implicit knowledge. We need to create systems that are universally accessible and shared across the industry, functionally integrating the wheat breeder and miller with the cereal chemist and baker. We will need to align business practices that facilitate and integrate such relationships.

What specifically does this mean to the field of cereal chemistry? The outcomes of your work will demand near perfection for ease of implementation and use. Your work will become participatory between your peers and customers. Much greater emphases will be place upon raw material consistency. Flour will remain the number one critical raw material with a much greater emphasis on consistency and stan-
Flour millers, cereal chemists, and bakery technicians will all need to be involved in crop research, breeding projects, milling and blending, and bakery equipment selection. Flour millers will be restricted from making random grist changes. Bakers will recognize that holding millers accountable for a specific percent-protein content is pointless and understand that wheat variety and protein quality are much more relevant to end-product quality.

In summary, baking in the 21st century will continue to challenge the ingenuity of science and technology while remaining checked within the constraints of investment capital. The only things that we can anticipate with certainty are that the rate of change will continue to accelerate, that we continue to explore and invest in new technologies (some which will work and some of which will not), and that the demands of the market place will force all of us to become far more than we ever thought possible.

References

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Thomas Kuk is president and CEO of the American Society of Baking. He has served in that capacity since 1996 and has been a member of the Society’s Executive Committee since 1993. Prior to joining the society, Kuk worked as a management consultant to nonprofit organizations focusing on computer integration and communications strategies. He currently serves on the Education Advisory Committee of the American Institute of Baking and the Kansas State University Grain Science Curriculum Review Committee. He has been active in community affairs by serving as a Scout leader for more than 12 years and in city government for 5 years. He has a B.A. degree in Journalism from Colorado State University and is currently pursuing a graduate degree in nonprofit organizational administration at the University of San Francisco. He is a voracious reader and political junkie. Kuk resides in Sonoma, CA where he has developed a growing interest in viticulture and winemaking. Kuk speaks frequently on various industry topics including technology and leadership development.

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