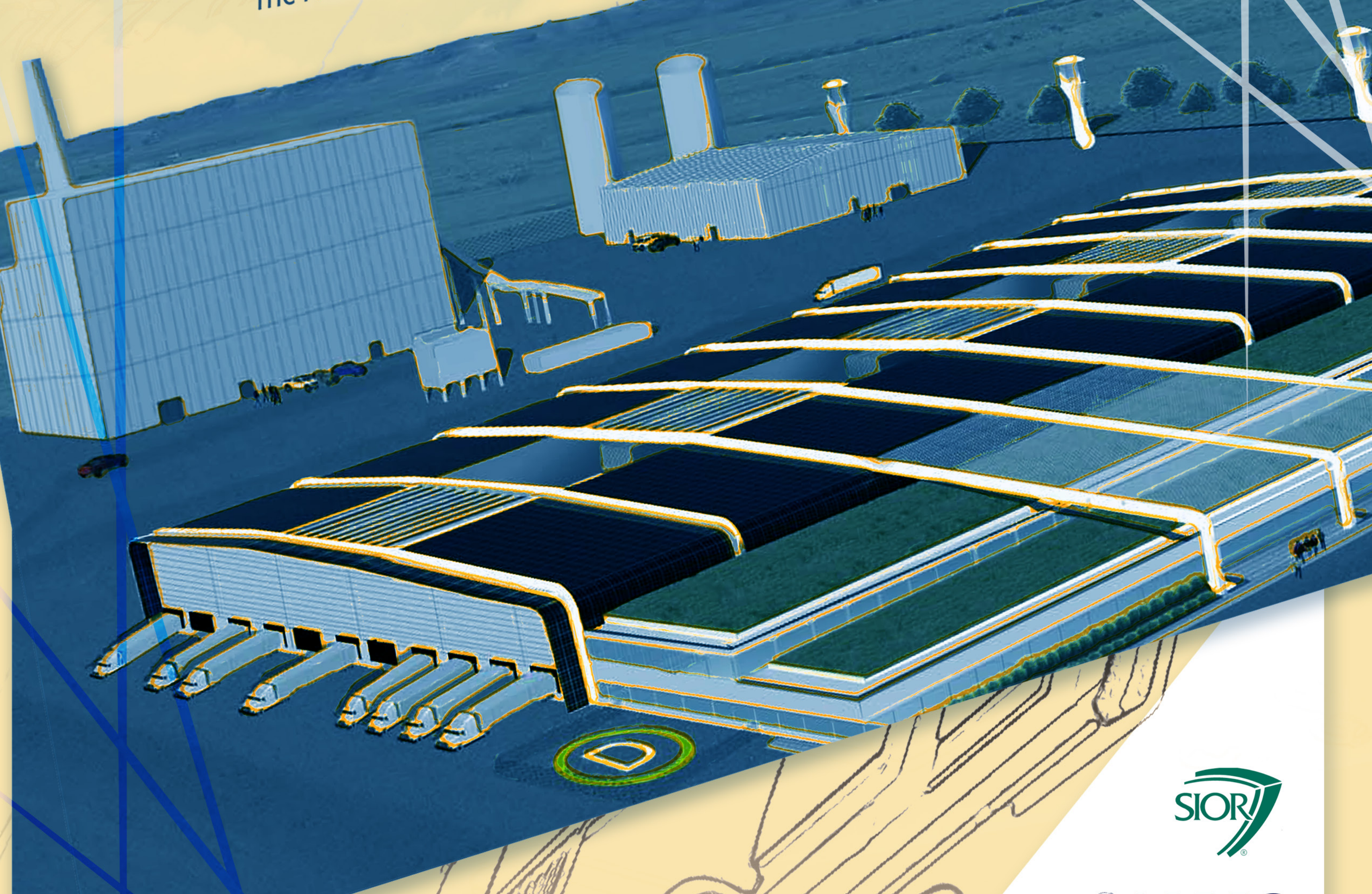
2015

DESIGN FLEX 2030

Recipe for Change

The Flexible Food Processing Plant of the Future



SIOR

IAMC
Industrial Asset Management Council

SIOR Foundation

CREDITS

> *As designed by the DesignFlex2030 Food Processing Design Team, the food processing plants of the future are safe, efficient, self-sustaining, flexible, and cost-effective, yielding long-term benefits for their corporate owners and economic value for communities.*

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Recipe for Change

The Flexible Food Processing Plant of the Future

FOREWORD

Use. Re-use. Adaptability. Flexibility. “Recipe for Change: The Flexible Food Processing Plant of the Future” is the first in a series of white papers under the DesignFlex 2030 umbrella, an initiative commissioned by the Industrial Asset Management Council (IAMC) and the Society of Industrial and Office Realtors (SIOR) with the goal of reimagining the industrial facilities of the future so they can be re-purposed quickly, efficiently, and cost-effectively as needs and users change.

The idea is not to be proscriptive: we are not seeking to lay out a single, straight, and clear path forward that would constrain, restrict, or define a specific way future facilities should be built. Rather, our intent is to start a different kind of conversation, by giving corporate users and the architectural and engineering firms that work with them creative and practical suggestions on how to extend the lifecycle of future industrial facilities, increasing sustainability, reducing cost, and improving ROI on their industrial real estate portfolio.

In this first paper, we look at a prototype for a more flexible food processing plant. The concept, as designed by our DesignFlex 2030 Food Processing Design Team, features six key areas of innovation that can help inform the future facilities plans of food processing firms as they face disruptive technological change, a shifting regulatory landscape, and rapidly turning business cycles.

We want to acknowledge the extraordinary work of our talented and visionary Food Processing Design Team: co-leads John Patelski and Wayne Young; Kevin Angell, Peter Clark, David Findlay, Mark Huettner, Matthew Stagemeyer and Malvin Warrick. This team, a remarkable and collaborative group of professionals, came together in record time, volunteered countless hours, and lent passion and enthusiasm to the project—a spirit that infuses the pages that follow. We thank their firms, Ghafari and Burns & McDonnell, for their donation of the team’s time and company resources to enable this work.

In addition, we thank our technical advisors—Ken Hagaman of Anixter, Steve Kozarits of Transwestern, John Lewandowski of ConAgra Foods, Tony Lucarelli of Henningsen Cold Storage, Roger Nesti of Kellogg Company, and Jennifer Roth of Bimbo Bakeries—for providing their wise counsel to our team.

We sincerely appreciate and thank Cresa, the exclusive sponsor of this report.

We gratefully acknowledge Trimble’s Nancy Sanquist, who contributed to the early research stage of the project. We also want to single out Joel Parker, IAMC’s director of professional research and education, who has worked quietly and steadfastly behind the scenes from the very beginning to ensure that this project would happen. Our thanks go to author Ann Moline, for her leadership and research skills, in addition to her writing.

Finally, we note with sadness the death of Dr. Peter Clark, an integral member of the design team who died just prior to the publication of this report. His contributions to this paper will be part of his enduring legacy of knowledge and professionalism.

On behalf of IAMC and our colleagues at SIOR, we invite you to peruse the pages that follow. We hope you will be as inspired as we are, and we look forward to continuing this conversation with you. Stay tuned for information about upcoming conference programming related to the DesignFlex2030 initiative!

DesignFlex2030 IAMC co-chairs

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Recipe for Change

The Flexible Food Processing Plant of the Future

IAMC
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SOCIETY OF INDUSTRIAL AND OFFICE REALTORS

SIOR Foundation

DESIGN FLEX 2030

Executive Summary

This paper is part of the DesignFlex2030 initiative, commissioned by IAMC and SIOR to explore the potential of new design approaches that could lead to more flexible, adaptable, and sustainable industrial facilities in the future.

The food processing industry touches a variety of industrial property types and concerns. This paper provides a comprehensive review of the DesignFlex2030 Food Processing Design Team's vision of the food processing plants of the future: safe, efficient, self-sustaining, flexible, and cost-effective. As envisioned by the team, such plants stand to yield powerful long-term economic benefits for their corporate owners and communities where they locate.

The paper unveils the team's conceptual rendering; highlighting six areas of innovation and proposing a new way to consider costs and returns on investment as part of the business case for flexibility. In addition, it offers recommendations for economic developers and federal, state, and local policy-makers on ways to encourage the construction of more flexible industrial facilities; and suggests directions for future research and exploration.

Key aspects of the design

» Location proximity to dense population centers for rapid access to customer markets in response to growing demand for fast, fresh, and local foods

» Architecturally significant, energy efficient exterior envelope for better alignment with surroundings, increased public acceptance, and energy savings

» Open interior structure to accommodate slide-in/slide-out prefabricated modular units for maximum flexibility, ease of adaptation as needs change, and increased value at point of sale

» Fully automated processes to increase yields, improve productivity, minimize workplace dangers, reduce risk of contamination, and enhance food safety

» Rain runoff collection system and co-located waste water treatment to reduce reliance on ever scarcer public water sources

» Daylighting, solar panels and wind turbines to more than meet energy demand, generating enough excess power to contribute to the grid

» Embedded smart technologies and fully networked environment to enable real-time 360-view of entire value chain, more efficient operations and more effective strategic decision-making

Introduction

Once upon a time, food processing plants were built to last forever. Churning out the same basic products year after year, with little change in inputs, process, or packaging, some older production facilities were in continuous use for more than 100 years.

The days of this kind of process and product continuity are gone forever. Business cycles turn faster, consumer tastes and trends change more quickly, and the rapid pace of technological innovation renders recent upgrades obsolete almost before they pay for themselves.

The result is that the average lifecycle of today's newly built food processing plant is 20-to-30 years, with some production lines shutting down after only a few years of operational use. When needs change and the plant no longer serves the purposes of the corporate user, the typical approach is to try to sell the often highly specialized building. The owner may wind up holding on to it for months or years until someone else agrees to buy it, likely for pennies on the dollar. This can cause maintenance budgets to soar, with annual carrying costs that could run into the millions, ultimately yielding a marginal return on investment at the point of sale.

It's an issue of concern, and not just for the real estate owners or the corporations that hold their own industrial real estate portfolios. In fact, it is one of the underlying causes of the kind of blight that local, state, and federal officials often rail against: the vast swaths of vacant, outmoded and unusable industrial buildings that pose an obstacle to new investment, potentially derailing economic recovery and a turnaround in a community's fortunes. In Detroit, for example, a city that is trying hard to move toward a more stable future following years of economic turbulence, the cost to tear down abandoned industrial buildings and remediate the sites for new corporate development could run as high as $1 billion, according to a recent federal study.

Corporate real estate executives cite several reasons their companies do not build for the longer term. One reason is that plants are often filled with specialized and permanently installed equipment, making it costly and time-consuming to adapt them for other uses. "Our legacy plants have a lot of infrastructure, and are highly specialized. Once they are closed, adapting them for other purposes is often a challenge," notes Roger Nesti, director of international real estate for Kellogg Company.

Another reason is the business uncertainty that is a given in today's volatile economic environment. "We build for what we will need right now, because it's too expensive to over-build in anticipation of what the building may or may not become in the future," says John Lewandowski, Con Agra Foods' senior director of real estate.

Such issues present significant obstacles to building beyond the current need. But what if there were a different way?

In this paper, we set out to answer this single question by looking at it in two ways

1. What will the food processing plant of the future look like?
2. How can new approaches, including design innovations, emerging technologies, policy prescriptions, and changes in mindset enable increased flexibility, adaptability and reuse?

By weaving flexible design concepts and innovative technologies into the building's structural DNA, we seek to provide more facilities options and to demonstrate the viability of using and re-using the same facility for different purposes.

[1] A 2014 report from the federally-funded Detroit Blight Removal Task Force estimated that the cost to tear down and remediate all of the abandoned industrial buildings in the 140-square-mile city could total nearly $1 billion.(http://report.timetoendblight.org/intro/#11)

Food Processing Design Team

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BACKGROUND

As a follow-on to the well-received IAMC/SIOR study, Designing Flexibility into the Industrial Workplace, which focused on overcoming flexibility issues related to the existing stock of industrial facilities, IAMC and SIOR commissioned a project called DesignFlex2030, to explore the possibilities for the next generation of yet-to-be-built industrial facilities. DesignFlex2030 imagines a more flexible future for industrial facilities, a future in which buildings can be used and reused, repurposed and adapted more quickly and more cost-effectively.

To accomplish the goal, volunteer teams of award-winning industrial architects and engineers collaborated across companies and business lines to develop prototypes of highly flexible industrial facilities that feature a built-in capacity for continuous adaptability and re-use, even as business needs change, facilities turn over for new uses and new owners, and technological advances impact industrial facilities requirements.

In the early planning stages for DesignFlex2030, it became apparent that a one-size-fits-all approach could not address the full scope of issues faced in planning, siting, designing, and operating industrial facilities. In particular, generalizing on a single futuristic concept to cover the range of industrial facilities types would diminish the value of the exercise: the requirements for a food processing plant are not the same as the requirements for a pharmaceutical facility, for example.

This insight led to the decision to design prototypes of three different industrial facilities of the future, to more closely approximate the diversity of uses and requirements in the industrial universe.

These conceptual designs include:

- *Food processing plant*
- *Pharmaceutical research and development facility*
- *Distribution/logistics warehouse*

This paper details the work of DesignFlex2030's Food Processing Design Team and the flexible food processing facility prototype they created. Subsequent papers will highlight the work of the pharma and logistics teams.

*See bios in report appendix

FUTURE TRENDS IN FOOD PROCESSING

A quick look at the raft of online food sites, blogs, and message boards, as well as the number of food-related reality television shows and the emergence of glossy new food magazines gives a sense of how swiftly consumer tastes change. Today's hot trends are sold in tomorrow's "day-old" bin. These rapidly changing tastes represent a challenge for food processors, who need a crystal ball to try to predict what consumers will want to eat tomorrow.

It is precisely this constant churn that points to the value of increased flexibility on the food processing production line. The ability to rapidly change out and reprogram old production lines and act nimbly on emerging new food trends represents a significant market opportunity, particularly for large scale operators that have traditionally been slower to change out less popular product lines—and that may have seen their bottom lines struggle as a result.

Proximity to major customer markets, already a critical factor, will be even more important in the year 2030. Driven by consumer demand for fast, fresh, and local, as well as by rising transportation costs, a key consideration for future food plants will be increased proximity to their end customer, as well as the multi-modal logistics access that enables rapid transport and delivery options.

Location decisions will be determined by how close they can get to customers. "It is a pain to move raw materials a long way but the killer is moving finished product. It is advantageous to have that plant located in the general vicinity of the consumer," says ConAgra Foods' John Lewandowski. In the future, emerging transportation modes, such as Unmanned Aerial Vehicles—UAVs—also known as drones, are likely to alter this calculus even further.

The food processing plant of 2030 may require fewer workers, but those workers will need advanced skill sets. The availability of skilled workers, along with access to a talent pipeline and partnerships with the academic community to train the next generation of workers on the skills they'll need to be ready on day one, will play an important role in the site selection decisions of meat processing firms.

This represents a notable difference from the situation today. Unlike other industrial sectors that have invested in advanced manufacturing capabilities, requiring highly skilled operators to manage sophisticated computer systems, many food processing plants continue to rely primarily on manual labor along the production line. These workers must have on-the-job training and experiential learning, but they may not need higher education certifications or credentials to do their jobs. In the future, this is sure to change.

Energy self-sufficiency and availability of water will become increasingly critical. "Today, water recycling is a nice-to-have, but 20 years from now it will be a must have," notes Kellogg Company's Nesti. He adds that in emerging markets, energy reliability and the availability and quality of water supply are already significant issues for companies as they conduct site searches for new industrial facilities. Even on the domestic front, ready availability of water can no longer be assumed, as evidenced by recent droughts in states like California, where agribusinesses and food processing companies have suffered losses amounting to more than $2 billion in total economic costs for the state and 17,000 lost jobs in a single year, 2014.[2]

What will the grocery shelves of 2030 look like?

» Virtual grocery stores

» Customized packaging for convenience and demographic demands: arthritis-friendly yogurt containers and K-Cup baby formula

» Personalized food offerings for the range of diet preferences

» Local sourcing, local production

» Smart, connected products to monitor for food safety, metabolic impact, caloric intake and more

» Zero-emissions packaging

Already a significant concern for food companies, food safety and compliance with changing regulations is likely to become even more of a priority than it is today. KPMG's 2013 Food and Beverage Industry Outlook captures this looming issue. The annual survey of food and beverage executives revealed considerable heartburn over pending regulatory changes associated with the Food Safety Modernization Act, which could mean more requirements and increased costs. [3]

"Food safety is a huge, huge thing for companies in our industry," says Tony Lucarelli, Executive Vice President of Henningsen Cold Storage. "We are constantly trying to ensure compliance and that we stay ahead of the curve to meet future requirements. There is so much documentation, and you have to show that you are maintaining food safety standards at every step of the way." He adds that this pressure is likely to continue as more regulations are added.

Other future uncertainties that may impact food safety

[2] Economic Impact of the California Water Drought 2014," University of California Davis, May, 2014: watershed.ucdavis.edu/files/biblio/Economic_Impact_of_the_2014_California_Water_Drought_1.pdf

[3] Food and Beverage Outlook Survey 2013, KPMG, https://www.kpmg.com/US/en/IssuesAndInsights/ArticlesPublications/Documents/food-beverage-outlook-survey-2013.pdf, accessed 5/14/15

"FOOD SAFETY IS A HUGE, HUGE THING FOR COMPANIES IN OUR INDUSTRY."

— *Tony Lucarelli*,

Executive Vice President, Sales & Marketing, Henningsen Cold Storage

compliance include the potential for new free trade agreements and a push toward global harmonization of food safety-related regulations.[4]

Separate from compliance with regulations, the ability to ensure a safe supply of food products, from the beginning of the chain to the end consumer, is mission-critical for food companies. No one wants a recall, given the cost of pulling goods off shelves and the resources required to trace the source of the problem and remediate as needed—on top of the potential for catastrophic damage to brand image.

Consumers are paying attention, too. A 2010 survey for National Public Radio by Thomson Reuters revealed the extent of the anxiety: according to the survey, more than 60 percent of Americans are worried about food safety, with 51 percent expressing particular concern over the safety of the nation's meat supply.[5]

[4] Global Food Safety Initiative, http://www.mygfsi.com/about-us/about-gfsi/what-is-gfsi.html

[5] Nameth, Alexa, "Meat: America's # 1 Food Safety Concern," Food Safety News, August 2,2010, http://www.foodsafetynews.com/2010/08/meat-americans-number-one-food-safety-concern/#.VVUcw_lViko, accessed 5/14/15

FOCUS ON MEAT-PACKING PLANTS

This is what the inside of a meat processing plant looks like today. Production lines require intensive manual labor, yielding a high rate of workplace injuries and workmen's compensation claims. Source: "Video Tour of a Pork Plant Featuring Temple Grandin" [7]

As the starting point for their prototype, the DesignFlex2030 Food Processing Design Team selected a meat processing facility. The selection was purposeful.

Today's meat packing plants come with a host of difficulties, making them the among the least desirable economic development additions to communities and among the most challenging for the food processing industry itself. "When you hear about design competitions for new buildings, rarely do thoughts turn to meat packing plants," notes DesignFlex2030 Food Processing Design Team member Mark Huettner. "And yet, these are among the industrial buildings most in need of a design overhaul."

Even plants that abide by the highest operational standards are not particularly pleasant places. Among the least automated industrial facilities, they require large numbers of workers, doing bloody jobs by hand. One study, from Human Rights Watch—admittedly an organization with an activist agenda—found that for each work shift, workers make up to 30,000 hard-cutting motions with sharp knives, causing massive repetitive motion injuries and frequent lacerations.[6] "Meatpacking is the most dangerous factory job in America," notes Lance Compa, a labor rights researcher for the organization, in the 2005 study.

Ten years after the publication of that report, things have changed and conditions have improved, to be sure. Nevertheless, at 5.3 per 100 workers in 2013, the industry still has among the highest incidences of workplace injuries and illnesses severe

"THERE ARE SO MANY GOOD REASONS TO TRY TO GET PEOPLE OUT OF MEAT PROCESSING PLANTS. THEY ARE DOING VERY HAZARDOUS AND VERY NASTY JOBS."

— *Peter Clark*,
DesignFlex2030 Food Processing Design Team member

[6] http://www.hrw.org/news/2005/01/24/abuses-against-workers-taint-us-meat-and-poultry

[7] https://www.youtube.com/watch?v=LsEbvwMipJI

Challenges for today's meat processors

» Specialized plants that are difficult to re-sell or repurpose

» Manual processes

» Unpleasant working conditions

» Among the highest rate of workplace injuries, repetitive motion strains and workmen's compensation claims

» Public relations issues

» Lack of consideration to aesthetics

» Extensive water and energy consumption

» Food safety issues

» Regulatory requirements

enough to cause days away from work or restricted job activity, according to the US Bureau of Labor Statistics.[8] The sheer fact of people wielding heavy, sharp, motorized saws in close quarters all day every day speaks to the ever-present danger lurking. It's a key reason that meat processing companies today are actively seeking ways to reduce ergonomic stress and improve productivity.

"There are so many good reasons to try to get people out of meat processing plants," notes Ghafari's Peter Clark, a member of the DesignFlex2030 Food Processing Design Team. "They are doing very hazardous and very nasty jobs, opening the animal and taking apart the entire carcass by hand."

Other industries have addressed similar workplace safety challenges by replacing personnel with electronically controlled machinery and equipment. Meat processing companies remain well behind the robotics curve compared to manufacturers in industries such as automotive and aerospace. For example, in 2013 alone, Great Britain's automotive manufacturers bought 11 times more robotic equipment than their meat processing counterparts, according to Meatpacking Journal, a trade publication. Industry experts cite several reasons for this discrepancy:

- *High upfront cost of automated, robotic equipment and relatively low value of the products sold: automotive and aerospace companies can quickly make up the return on their robotic investments through the sale of their high-dollar products, while a meat company would have to sell a whole lot of pork chops to earn back a similar outlay.9*
- *Lack of automated precision adjustment capabilities: the disassembly of an animal carcass requires precise cuts in specific spots. For beef processors in particular, the exact location of the cut might not be the same every time due to size and shape variations from carcass to carcass. This makes programming for repetitive robotic motion exceedingly difficult.10 To invest in robotics only to discover a higher volume of waste due to inaccurate cuts, yielding lower productivity and increased cost, would not seem to make good financial sense.*

However, a change in attitude toward automation is gaining traction in some sub-sectors of the industry. This shift is sure to pick up momentum in the future. "We have started to see some pork processors looking to replace outdated equipment and facilities with higher speed, automated equipment and higher throughput lines in an effort to improve consistency and yield, as well as for improved traceability," says Ghafari's John Patelski, Food Processing Design Team co-lead.

[8] U.S. Bureau of Labor Statistics, "Highest incidence rates of nonfatal occupational injury and illness cases with days away from work, restricted work activity, or job transfer," 2013TABLE SNR02, http://www.bls.gov/iif/oshwc/osh/os/ostb3963.pdf, accessed January 12, 2015.

[9] Owen, Rhian, "At the limits of automation," Meatpacking Journal, May 4 2014. http://meatpacking.info/2014/05/04/at-the-limits-of-automation/, last accessed 5/21/15.

[10] IBID

DEMAND FOR MEAT IS NOT GOING AWAY

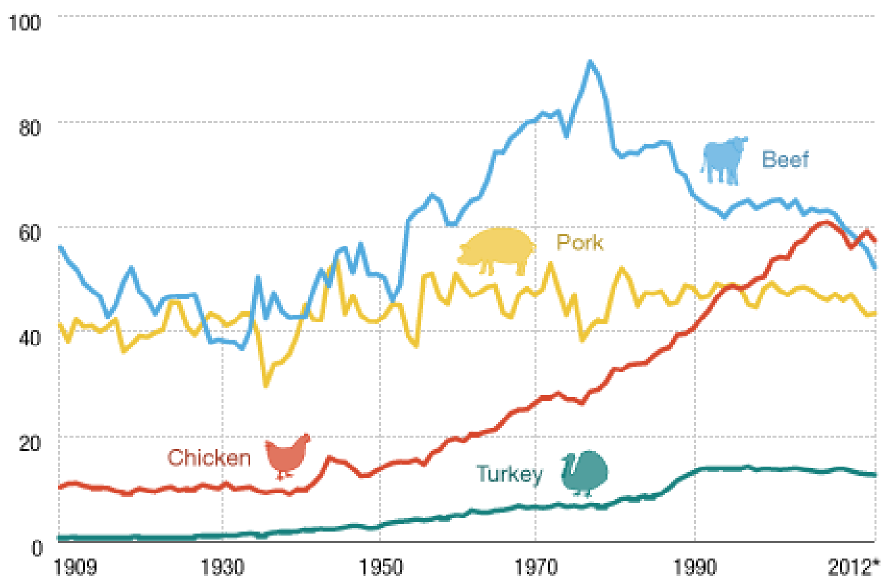
While the debate over the moral implications of animal-based diets continues, and what goes on inside meat packing plants remains a topic of interest for activists of all stripes, the fact is that global demand for meat continues to grow. Some estimates suggest that by 2030, a typical person will consume nearly 100 pounds of meat each year.[11]

In the United States, consumption of red meat has leveled off in recent years, but it remains at high levels. Despite an increase in the number of vegetarians and a push by health advocates to reduce the amount of red meat in the daily diet, there are few indications that Americans will eat significantly less meat in the coming years.

With these considerations in mind, the DesignFlex2030 Food Processing Design Team set out to develop a safer, more efficient, more productive, and more environmentally friendly facility that:

- *adapts for other uses easily and cost-effectively, including "dry" food processing facilities, distribution facilities, or other office, retail, or residential uses;*
- *reduces the need for permanently installed specialty equipment to enhance long-term financial value;*
- *minimizes workplace injury risks and improves productivity;*
- *represents an attractive addition to the community and a value-add to the economic development landscape, changing the way people think about industrial facilities; and*
- *is located in proximity to mass transit and multi-modal distribution corridors.*

US meat consumption per person, in pounds. Source: Earth Policy Institute; credit: Angela Wong/NPR

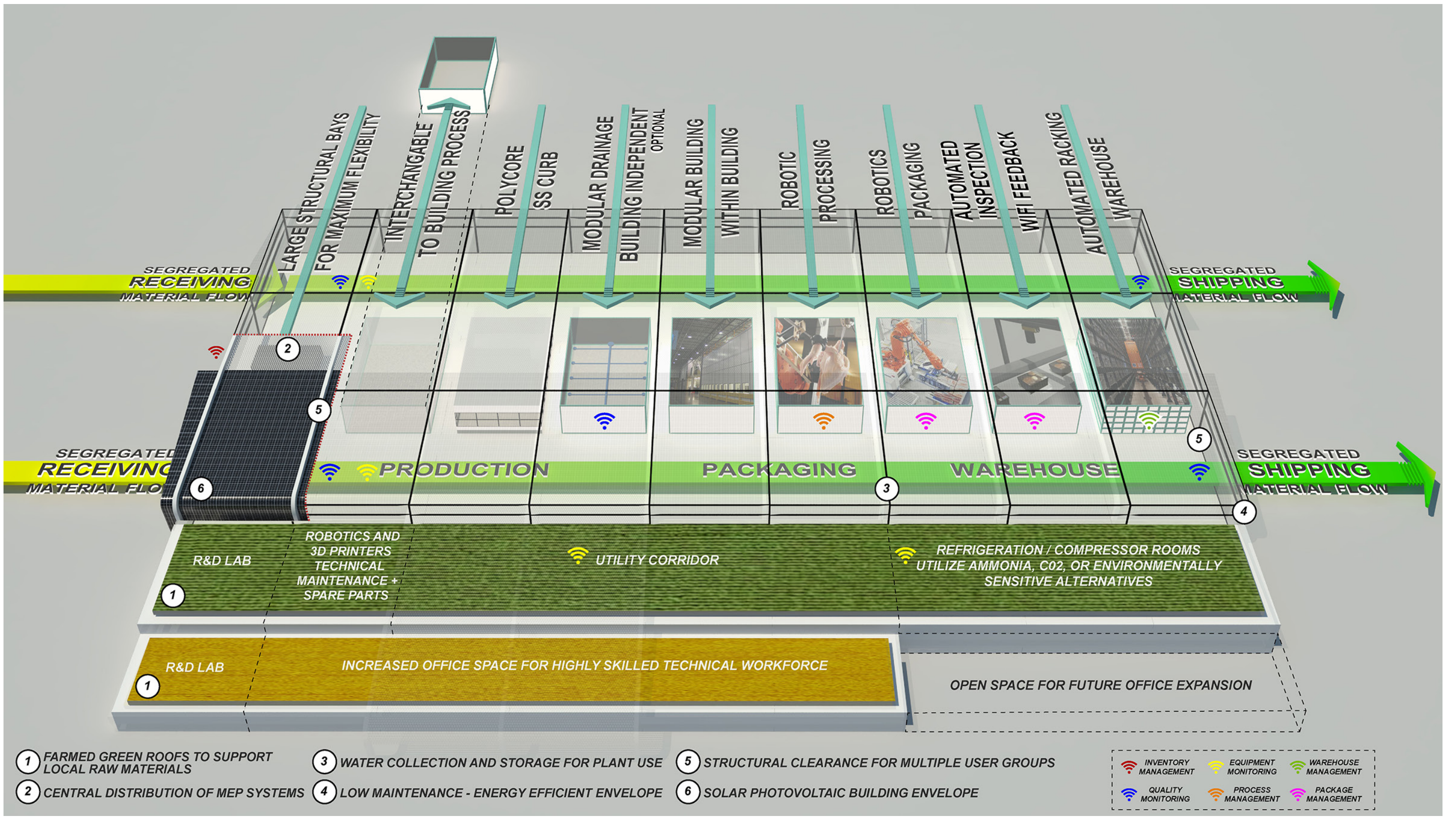


[11] Feldman, Roberto A., "Science is chewing on the world's meat issue," The Washington Post, May 21, 2015.

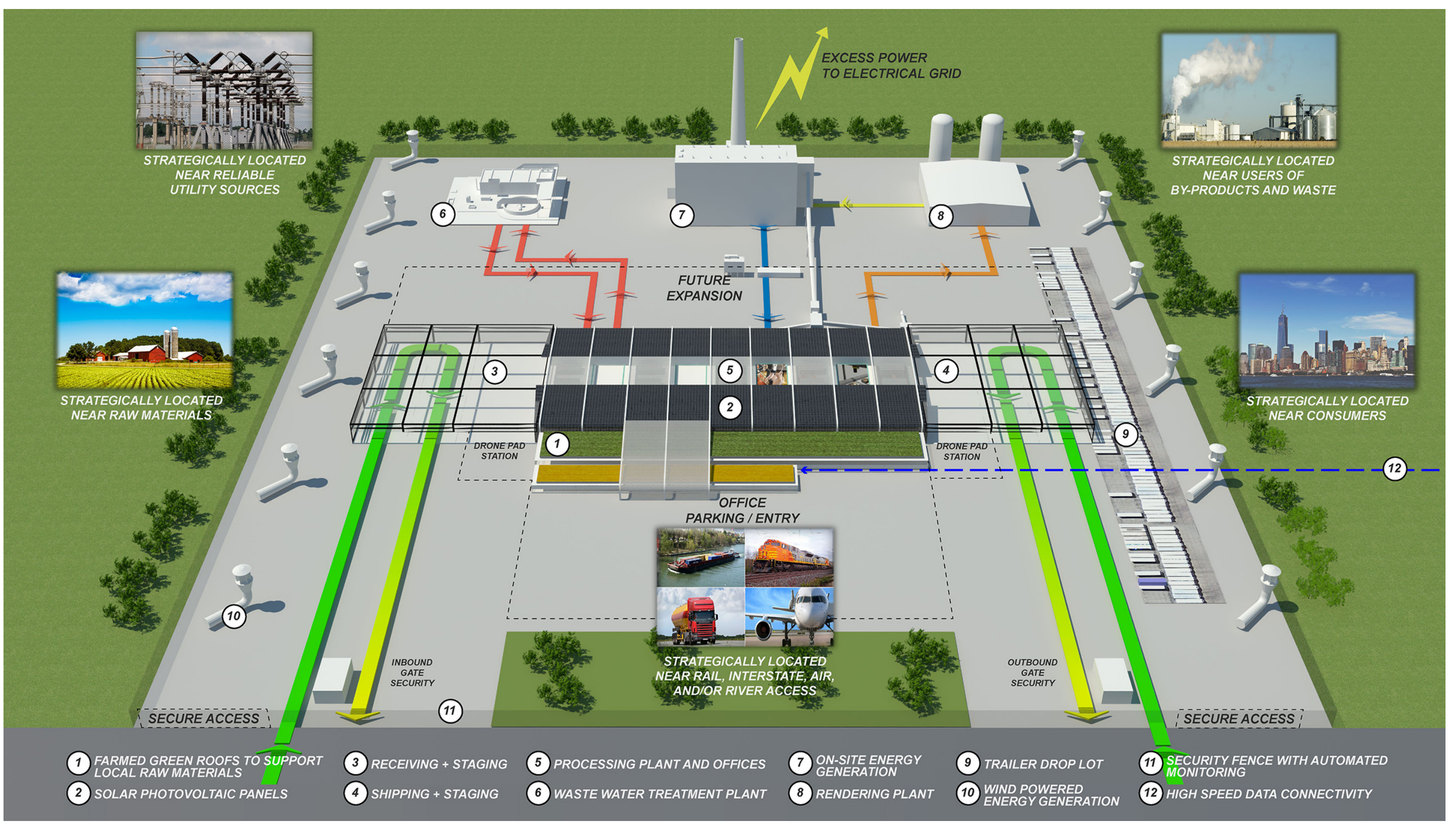
THE FLEXIBLE FOOD PROCESSING PLANT OF THE FUTURE

- Architecturally significant, energy efficient building envelope with sleek design features and attractive landscaping
- Single level, open plan to facilitate modular conversion within production areas and interaction and collaboration among user groups
- Minimal use of hard-to-remove concrete
- Light-weight materials like polyurethane core-filled stainless steel
- Self-contained modular buildings-within-buildings for efficient conversion to future uses
- Modular floor drain system installed over base level floor with sub-floor in between to enable draining
- Retractable and expandable walls and roof system for module transfer and higher ceiling heights for future uses
- Maximized roof span and minimized roof-top equipment; farmed green roof
- Robotic transportation routes for material flow; 3-D printers for parts replacement
- Air filtration system for reduced risk of air-borne contaminants and elimination of biological odors
- Segregated spaces to minimize risk of cross-contamination, contain noise, and reduce downtime during a conversion process
- Sustainable on-site renewable energy, with wind, solar, battery-enabled energy storage, and maximized use of natural light
- On-site water generation and waste water treatment
- LED lighting and lighting control systems
- Centralized distribution of utilities and flexible connections
- Environmentally-benign refrigerants
- Perimeter employee amenities such as outdoor break and activity areas
- Co-located research and development, packaging for grocery shelves, marketing, offices, cold storage
- On-site rendering plant to prepare animal by-products for sale in secondary markets
- Net-zero utilities, waste, and emissions
- Internet of Things: fully networked facility connecting food safety, environment, quality, operations, inventory, process, packaging, facility monitoring and management

Meat processing plant of the future, external view



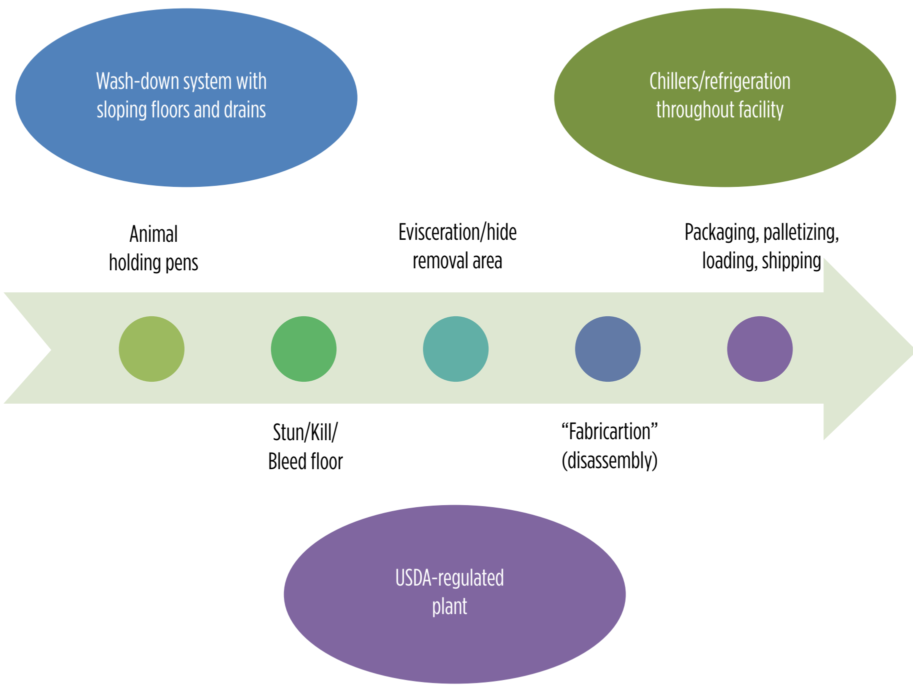
Meat processing plant of the future, plant-level view



Meat processing plant of the future, site-level view

THE FACILITY PROTOTYPE: 6 INNOVATIONS THAT YIELD CORPORATE AND COMMUNITY BENEFITS

Meat Packing Plant: A Horizontal Process Flow



"THE HEART OF THIS FACILITY'S FLEXIBILITY IS SLIDE-IN/ SLIDE-OUT MODULARITY."

— *Matthew Stagemeyer,*
Burns &McDonnell, DesignFlex 2030 Food Processing Design Team member

Although technology is not the story itself, technology—and its generational evolution to drive ever smarter, ever more connected, and ever more efficient industrial processes—underpins the prototype as rendered by the DesignFlex2030 Food Processing Design Team. It enables innovation on virtually every front, yielding significant benefits for corporate users of such facilities, as well as the communities where they will be located.

INNOVATION #1. *Structure*

The building itself is a shell with an open layout, featuring few structural columns that would impede flow and no permanent specialty equipment. The shell houses self-contained prefabricated modules that include all necessary equipment and that slide in for use and slide out when needs change. "The heart of this facility's flexibility is slide-in/slide-out modularity," notes Matthew Stagemeyer, Food Processing Design Team member.

This approach enables an efficient way to respond rapidly as needs or uses change—if, say a sudden surge in vegetarianism drastically reduces the demand for meat. It represents a cost effective alternative to building a new facility, with its lengthy construction timeframe, or to repurposing a portion of a traditional facility, requiring significant downtime to reduce the risk of construction-related contamination.

The outer envelope's shell of lightweight aluminum is wrapped in thin, pliable, translucent solar wall panels with a color scheme chosen for maximum attractiveness. The structure's walls retract virtually the full length—similar to pocket doors—to enable easy slide-in/slide out delivery and removal of the prefabricated modular units that create the core operational centers of the facility. They also expand and retract vertically, so the roof can be raised to accommodate future uses that require increased height, such as a warehouse or distribution center.

About the "skid" modules

The slide-in/slide-out modules proposed are highly engineered, technologically advanced, and completely self-contained. With an NSF-compliant design,[12] they are clean rooms prefabricated off site with void-free construction and lightweight, non-porous materials. This reduces the risk of vermin infestation and supports sanitary wash-down capabilities, explains Food Processing Design Team member David Findlay.

Similar to an electronically enabled erector set, the modules arrive on trailers as flat packs or semi-constructed units. They slide inside the retractable walls of the plant, click into place, interconnect, and communicate with each other. Interior walls can retract to allow for process flow from one module to the next or to segregate specific activities as needed.

Once joints are connected and the modules are pieced together, units are elevated above the level of the base. Each module has drains that flow to dedicated sump pumps and connect to a unified drainage system, with floors that can be angled for better drainage. "The modular drainage system makes it a lot easier than digging up concrete when needs change," Stagemeyer explains. At estimated assembled dimensions of about 40 feet long, 13 feet wide and 14 feet high, a single module would span about 10,000 sf of floor space.

Adds Findlay, "The idea is that you could have three or four strung together with removable wall panels, creating a sequential arrangement and providing unidirectional process flow. You can activate the water spray or moderate the temperatures required for different parts of the process remotely through a smart climate and utilities control system."

The self-contained units include:

- *Radial welded stainless pipe, vessels and structural skids*
- *Protective sanitary shrouds*
- *Module-supported, stainless steel-skinned, insulated metal panel system*
- *Outside bolted flange and gasketed joint system where the modules connect*
- *Floors with drains and sloping capabilities*

Key benefits of modularity

Fabricators of such products estimate that use of modular process skids can yield 24 percent savings over traditional building costs.[13] While such specialized modules might cost upwards of $300-$400 per square foot in today's dollars, it is likely that future process and material innovations will bring this cost down. Additional financial benefits include:

» Use of modular units makes it easier to minimize permanent specialty requirements in the larger facility, facilitating quicker conversion to other uses and increasing the value of the facility for future users. This will enable a faster re-sale or a more cost-effective adaptive re-use project.

» Tax law allows equipment to be depreciated over a series of years, and these modules in their entirety could be considered depreciable equipment.

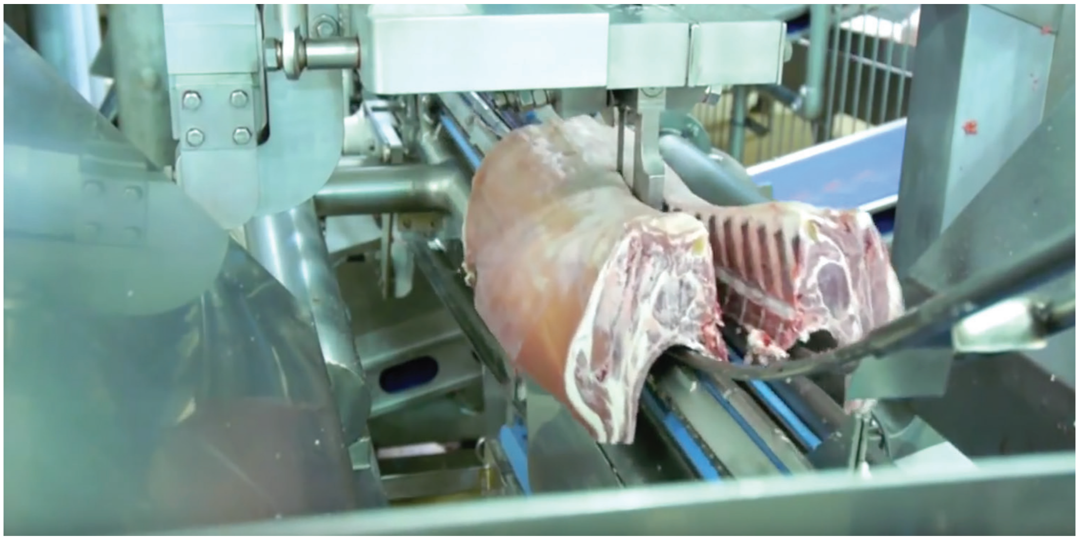
» Because equipment budgets typically fall under a different bucket than capital construction, the cost of the specialized modules could be deferred to the equipment budget, reducing the capital construction budget.

» An after-market for used modules is sure to develop as this approach becomes more common. "They will create their own secondary market," says DesignFlex2030 team co-lead Wayne Young. The original users would likely be able to earn back some of their investment through resale, he adds.

[12] Third-party certification providing assurance that a certified product, material, component or service complies with the technical requirements of the referenced standard. For more

information please visit: http://www.nsf.org/regulatory/regulator-nsf-certification/

[13] Epic Modular Process Systems & Pilot Plants, https://www.epicmodularprocess.com, accessed 5/15/15



Scott Technology's automated boning system is an example of the meat packing technology of the future. Source: Scott Technology Limited

INNOVATION #2. *Process*

The prototype facility features fully automated meat processing, powered by next generation robotic arms with guided systems for precision cuts every time, humanoid robots with artificial intelligence, and driverless vehicles for warehousing and loading. The use of automation embedded in the skid modules, as well as the fleet of humanoid robots and vehicles, results in a safer work environment and a more efficient and productive facility, able to run 24 hours, seven days a week, if needed.

As noted earlier, use of automation is on the rise in the meat industry, particularly with pork and lamb processors. With the introduction of technologies such as x-ray, ultrasound and enhanced vision systems to identify optimal spots for cutting, automation solutions are becoming more sophisticated, capable of handling more diverse carcass shapes.[14] The ability to reduce waste and improve yield through more precise carcass slicing could yield hundreds of thousands of dollars in savings—a major win for companies in a notoriously tight margin business, Patelski says.

As the technology evolves and use of new equipment becomes more commonplace, prices will come down and an after market for used machinery will develop, yielding increased affordability, even for smaller manufacturers.

Intelligent robots for industrial uses

The use of robots also will gain traction, as humanoid robots with artificial intelligence, cognitive language and fine motor skills—currently in the developmental phase—are commercialized and made available for industrial settings.

"The commercialization of humanoid robots that can react and respond to verbal commands requires a synergy between engineering and computer science that is probably about four generations of technological improvements away," says Yiannis Aloimonos, a professor of computer science at the University of Maryland who has developed a robot prototype with these capabilities. "While that sounds like a long time, generational cycles in technology are exceedingly short, so four generations is only about 15 years from now."

Aloimonos, also director of the university's Computer Vision Laboratory, is working with colleagues to commercialize the humanoid robot technology. The goal, he says, is convenience, minimal maintenance, and affordability for industrial users. Companies would sign service contracts for use of the robotic fleet, which would include a one-time up-front charge and a monthly service fee. "The one-time charge would depend on the sophistication of the application, such as fine-motor hand dexterity, ability to grasp a chain saw, and the like," Aloimonos explains,

[14] Owen, Rhian, "At the limits of automation," Meatpacking Journal, May 4, 2014. Last accessed May 20, 2015. http://meatpacking.info/2014/05/04/at-the-limits-of-automation/

with per robot discounts for larger fleets. The monthly service fee would amount to a fraction of the total monthly salaries of the workers replaced, he says, yielding significant labor savings.

3-D printing of spare parts

The facility also features a set-aside area with 3-D printers for rapid replacement of equipment or robotic parts, reducing the need to stock spare parts inventory and minimizing downtime due to back-ordering of essential equipment components.

Sensors and molecular diagnostics for increased food safety

Smart technologies such as embedded sensors, molecular diagnostics, and biometric monitors can detect pathogens, reduce the risk of contamination, and help ensure quality control and food safety. These tools, networked to cloud applications, also reduce the need for human inspectors and manual form completion, making it easier and less expensive to comply with ever more stringent food safety regulations—even if such regulations change. Already, the cost of such technology is on the decrease, making it a more affordable option for food processors. "Sensor costs are half today what they were a decade ago, while bandwidth has increased 40 fold and processing speeds are 60 times faster," writes Kevin Higgins in Food Processing magazine [15].

Note that the issue of how such automation impacts workers, while an important one to explore and address, is beyond the scope of this paper.

Key benefits of process innovations

» Increased flexibility to meet changing demand: reprogrammable robotic equipment and on-site replacement parts enable rapid alteration to production lines

» Improved worker safety

» Reduced workmen's compensation claims

» Reduced waste

» Improved yields

» Enhanced efficiency and productivity

» Better quality control

» Reduced risk of contamination

» Increased food safety

» Improved monitoring and more efficient regulatory compliance

» Easier adjustment to meet new requirements

Next-gen wind turbines: quiet, efficient, bird-friendly, and unobtrusive

The design evolution of the traditional windmill is representative of the changes in the alternative energy industry. For example, one next generation wind company, called Sheer Wind, has developed low-to-the-ground turbines that can be encased in an attractive exterior shell to blend with surrounding landscape.

They're also a lot less expensive. According to George Manos, Sheer Wind's CEO, "Today's windmills cost about $1300 per kilowatt hour to install. Ours cost about $700 per kilowatt hour."

Generation costs are vastly lower as well: 1 cent per kilowatt-hour, compared to the current standard of about 6 cents per kwH.

At about one-third the size of existing windmills, Sheer Wind turbines are less costly to transport, more reliable even in times of no wind, and easier to control in exceedingly high wind. The next gen turbines also come without the side effects of today's turbines: negative impacts on the bird and bat population, noise pollution from persistent humming, and intrusive sight lines, Manos says.

[15] Higgins, Kevin T. "IoT Meets Food and Beverage Processing." Food Processing magazine, June 8 2015.

INNOVATION #3. *Utilities & Environment*

The DesignFlex2030 food processing plant prototype features complete energy independence and self-sustaining water generation, as well as positive contributions to the environment through air filtration, on-site water treatment, heat recovery, and use of alternative energy sources.

Daylighting, solar panels and wind turbines more than meet energy demand. A co-located power station sends any excess power back to the grid for use by the community. While the rendering operation, scald tanks and other equipment would be high energy users, they also produce significant amounts of waste heat. As designed by the Food Processing Design Team, the meat processing plant of the future deploys a heat recovery system that makes use of this waste heat for input to absorption chillers and microturbines, thus reducing the load to the grid.

Current obstacles to more widespread adoption of such technologies, such as cost and reliability, will likely be overcome by the year 2030, as evidenced by the evolution currently taking place in the wind and solar industries.

With minimal roof-top equipment, the roof can accommodate a farmed green section as well as solar panels. Other environmentally friendly features include use of battery-powered and electric vehicles to support packing and loading operations for reduced emissions and an on-site rendering plant that minimizes waste. Environmentally benign refrigerants such as ammonia and CO2 replace ozone-depleting chlorofluorocarbons. Next generation air filtration systems enhance sanitation and eliminate biological odors.

Many companies already have embedded environmentally-progressive features in their facilities, viewing such investments as a way to add value beyond a dollar-for-dollar financial return. They see sustainability initiatives as a brand enhancement as well as an important recruitment tool to attract top talent. In addition, many have a strong and genuine corporate commitment to social and environmental sustainability. Others have yet to do so.

In the future, it is anticipated that regulatory changes and new environmental policies may take some of the decision-making over whether to add sustainability and how much out of the hands of the corporate owners of industrial facilities. Increasingly, state and local governments are enacting regulations to require use of low-impact development techniques and building to a certain standard of energy efficiency and environmental sustainability, such as a LEED certification. Already, some major US cities including Los Angeles, Miami, Boston, San Francisco, Baltimore, Washington, require certification for new commercial construction.[16]

In addition, as water scarcity becomes an ever more pressing issue, the ability to generate sufficient water for industrial needs will become increasingly important—particularly for uses such as meat processing, which is heavily reliant on water for sanitary wash-down.

The DesignFlex2030 Food Processing Design Team believes that many of the environmental enhancements included in the rendering will be required elements of all future facilities, rather than nice-to-have add-ons.

Key benefits of utilities and environmental innovations

- Net-zero utilities: the facility will not consume any more energy or water than it can generate on its own
- Net-zero waste
- Net-zero odors and emissions
- Reduced reliance on public water and power
- Increased energy efficiency
- Lower energy costs
- Brand enhancements

[16] "In U.S. building industry, is it too easy being green?" Christopher Schnaars and Hannah Morgan, USA Today, June 13, 2013.

INNOVATION #4. *Design*

A more harmonious blend of form and function, this is not your grandfather's meat packing plant. Newer building materials with hygienic coatings and more durable alternatives to concrete allow for more architecturally significant designs that represent a strong addition to the community. Sleek, translucent, and pliable solar panels, powered by nanotechnology, encase portions of the walls and roof as both a decorative covering and functional addition to maximize solar energy capture. The extensive water, wastewater, and air systems required by a meat packing facility transect the entire campus, below ground, inside, and outside. The centralized exterior piping and chases for these systems, encased in an attractive coating, become part of the overall design aesthetic. Wind turbines are sleek and lower to the ground to reduce visual impacts.

The office, laboratory and employee amenity areas at the perimeter of the facility feature floor-to-ceiling windows that create daylight awareness and an open and airy feel. Selected interior finishes contribute to employee health, wellness, and morale.

Extensive landscaping and natural site features help to buffer the facility and ensure a more cohesive fit with the surrounding community. Plantings are selected for their ability to grow in the local region as well as for their minimal water requirements.

While it may cost more to add features that will raise the attractiveness quotient, there are ways to mitigate such costs, experts suggest. "Development-related incentives could offset some of the additional costs," says Mark Beattie, a principal with Hickey & Associates, a global site selection, public incentive advisory and workforce solutions company. However, such incentives aren't always easy to come by. "If companies want incentives, they have to demonstrate the value proposition that they offer," Beattie says. A company that proffers a more attractive, energy-efficient, and flexible facility might have a better chance of accessing incentives—as well as finding a faster, less costly and less contentious route through the zoning, permitting, and approvals process. "Communities don't want unattractive assets that could quickly become vacant eyesores," he adds. Tapping into pools of state, regional, and local incentives might require a slightly larger company investment in better design—as well as a significant community outreach and education effort to demonstrate the value that the new facility would bring.

Key benefits of design innovation

» Increased public acceptance

» Better community relationships

» Ability to attract and retain highly skilled workers for increasingly technical jobs

» Simplification of maintenance and clearing processes

» Heightened interest from economic developers

» Improved access to public funding sources, public-private partnerships, and incentives

» Brand enhancements

INNVOATION #5. *Location*

It's a trend that has already started, but is sure to gain momentum in the future: at the site level, food processing facilities of the future will be located closer to customer markets. This may mean more facilities with smaller footprints, supplying smaller geographic territories. The goal is to reduce transportation time and cost to meet growing demand for fast, fresh, local and customized foods at affordable prices. This trend elevates the importance of an increased focus on design and landscaping considerations for better alignment with the community's economic development vision and increased public acceptance.

At the plant level, the location innovation is about co-location: a growing convergence of activities not directly related to the core production functions of the facility. For example, shelf-ready packaging operations will be increasingly centralized on the site of the meat packing plant—rather than in the meat department of individual grocery stores.

Third-party providers of temperature controlled warehousing and distribution facilities likely will have an on-site presence to support food manufacturing plants in the future, a trend that has already begun.

Notes Tony Lucarelli of Henningsen Cold Storage, "We focus on co-locating our facilities adjacent to our customer's plants, thus establishing long-term partnerships with them so they can maximize their cold supply chain efficiencies."

Research and development, too, will have a place on site, so that emerging research such as lab-grown meat can be tested and commercialized more quickly and efficiently.[18]

Key benefits of location and co-location innovation

- Lower transportation costs
- Faster time to market
- Improved quality control and oversight
- Increased opportunity for cross-collaboration
- Potentially reduced food safety risks through less handling

Lab grown "shmeat" of the future

A recent study by Oxford University found that synthetically produced "shmeat" –for instance, meat grown in a lab petri dish from the harvested muscle tissue of cows—could significantly reduce greenhouse gases, along with energy and water use, while requiring far less land compared to cattle farming. Products could be customized to cut fat content and add nutrients to meet growing demand for personalized foods.[17]

[17] Winterman, Denise. "Future foods: What will we be eating in 20 years' time?" BBC News Magazine, July 30, 2012.

[18] Just as with the issue of job losses that might result from automation, the exploration of the moral, ethical, political, and economic implications of using lab-grown meat—while important—falls outside the scope of this paper.

INNOVATION #6. *Data & Analytics*

The food processing plant of the future, with its embedded smart technologies and flexible DNA, functions as the operational vehicle to carry out the company's strategic goals. Big data and analytics expand the site level advantages exponentially, creating a completely networked value chain, closing the circle of supply, demand, and everything in between.

On the supply side is the plant itself, with smart, wireless, mobile connectivity—the Internet of Things—for real-time capture, assessment, and analysis of every aspect of operations. From delivery of cattle to the holding pens, through processing, to electronic compilation of all food safety regulatory data, to packing and delivering finished goods to grocers' shelves, and even to tracking where individual packages are consumed, the entire process can be monitored. Billions of bytes of data flow constantly to the cloud, plugged into algorithms through SaaS—software as a service—and return as usable, actionable analysis and information.

On the demand side, facts and figures about what consumers are buying and not buying, gathered in real time, keep the senior management team informed about emerging trends. Combined with the massive amount of information coming in about what's happening on the supply end—say, a poultry disease or higher grain prices that impact cost of supply—as well as plant level information that can be gathered and analyzed, senior executives have a 360-degree operational view, enabling more informed decision-making. The built-in flexibility of the plant allows the company's strategists to rapidly implement these decisions, enhancing the company's ability to capture the leading edge of new trends and helping to mitigate the adverse effects of any future market volatilities.

Key benefits of data analytics innovation

» Increased knowledge: makes sense out of the massive amounts of real-time data flowing from all parts of the value chain

» Better connectivity across the value chain: creates a more thorough overview

» Improved strategic decision-making: allows a more nimble response to capitalize on emerging trends and changing consumer demand

» Enhanced opportunities for savings and new revenue streams: helps uncover process inefficiencies as well as future market potential

The Digital Food Processing Plant of the Future

» Mobility

» Cloud computing

» Big data and analytics

» Bio-scanning

» Social media

» Internet of Things (IoT)

» Humanoid robots

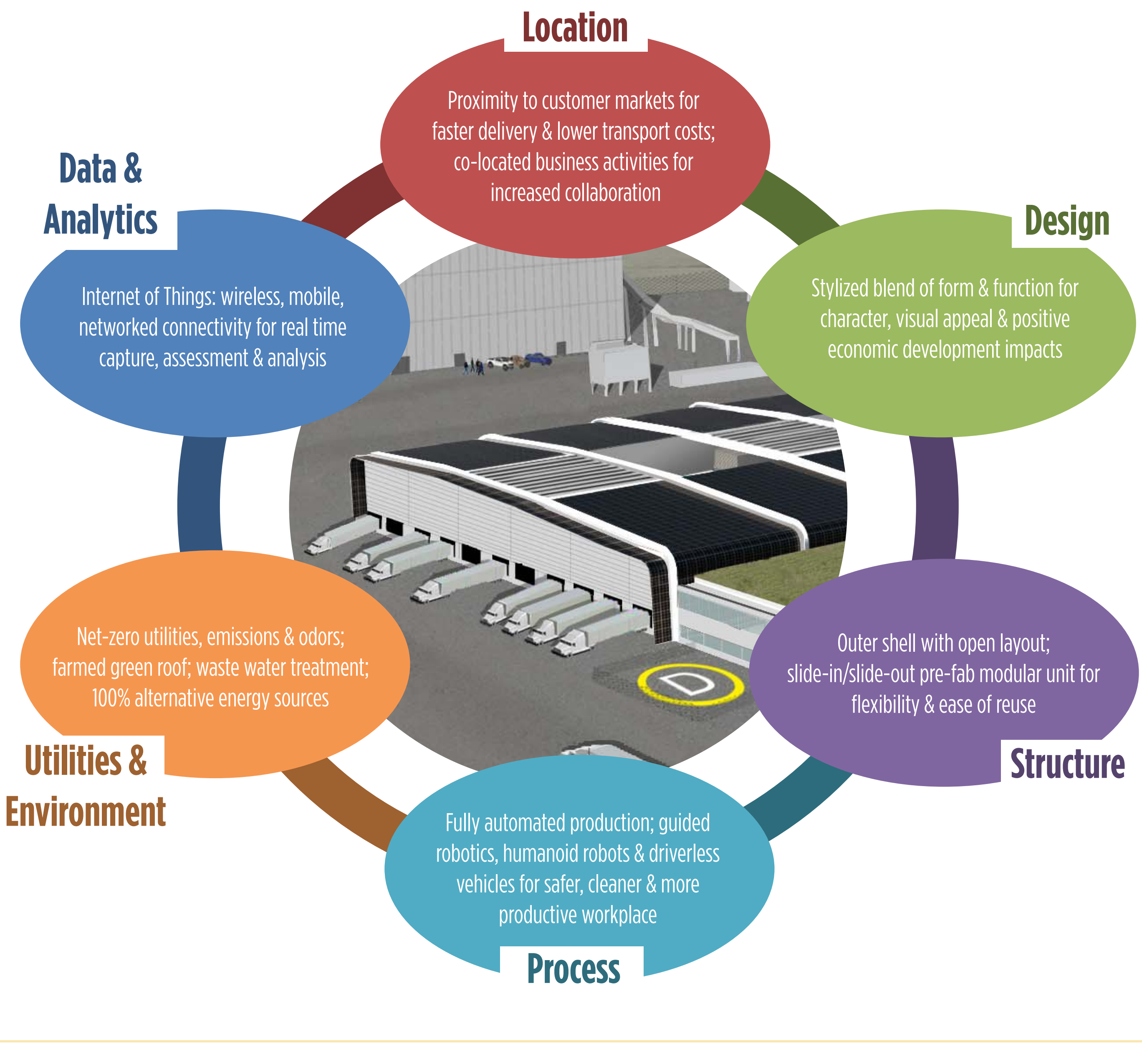
» 3D printing

» Integrated Workplace Management Systems (IWMS)

» Building Information Management systems (BIM)

Building a Better Mousetrap

6 food processing facilities innovations that benefit corporate owners & surrounding communities



ABOUT THE DESIGN PROCESS

Hand-selected by team leads John Patelski and Wayne Young for their diverse but complementary skills sets and expertise, the DesignFlex2030 Food Processing Design Team met weekly via conference call over the course of three months, February-April 2015. During this time, team members conducted background research to identify the central elements of three types of industrial facilities: a meat packing plant, a cereal plant, and a data center. In group discussions, they identified commonalities and differences, as well as a path forward to enable easier conversion from one use to the other. Round-table question-and-answer sessions with technical advisors from ConAgra, Kellogg, Bimbo Bakeries and Henningsen Cold Storage ensured that design concepts would be grounded in the reality of what the actual users of such facilities would require.

A small working group was tasked with creating the prototype itself, convening a series of off-line meetings to develop a graphic representation of the design concepts and pulling in additional staff resources as needed. "We met, discussed, converged, diverged, and converged again," says Burns & McDonnell's Mal Warrick of the working group's process.

After presenting the initial renderings, featuring the open plan and slide-in/slide out modularity to enable ease of conversion into three diverse industrial uses, the working group tweaked and fine-tuned concepts based on the entire team's input.

For more on individual team members, please see Appendix.

"WE MET, DISCUSSED, CONVERGED, DIVERGED, AND CONVERGED AGAIN."

— *Mal Warrick,*
Food Processing Design Team and working group member

COST AND RE-IMAGINING ROI

What stands in the way of increased flexibility?

It's not a failure of imagination or myopia in the face of an uncertain future. Instead it's pretty simple, according to corporate users of industrial facilities:

Cost.

Building beyond the current use might, indeed, cost more on a dollar-for-dollar basis than building only for the present need.

On the other hand, it might not. Decreased costs in some areas will help offset higher upfront cost in other areas:

- *As new technologies go mainstream they will become more cost effective*
- *On-site utilities, with self-generating capabilities and using more efficient alternative energy options, will reduce costs to less-than-grid parity*
- *Increased automation translates to reduced waste, improved product yields, lower labor costs and fewer workman's compensation claims*
- *An aftermarket for modular units is likely to develop, creating re-sale potential or allowing for discounted purchases of second-hand modules*

Notes John Patelski, Design Team co-lead, "The most dangerous question in the world to try to answer at the conceptual stage is: How much is this new facility going to cost? The reason it is so dangerous is that there are so many variables, ranging from location of the site to the size of the building, from building materials used to the extent of features added that it is really hard to generalize a cost estimate without understanding all aspects of the project."

> "THE MOST DANGEROUS QUESTION IN THE WORLD TO TRY TO ANSWER AT THE CONCEPTUAL STAGE IS: HOW MUCH IS THIS NEW FACILITY GOING TO COST?"
>
> — *John Patelski*, Food Processing Design Team co-lead

Design approach reduces capital budget

While getting at a specific per square foot cost would be challenging, the design approach suggested by the DesignFlex2030 Food Processing Design Team does allow for a different way to account for the various construction costs, potentially paving the way for tax rebates or other incentives associated with equipment upgrades and thereby reducing the overall cost to build.

How It Works

1. The cost to build what is essentially a shell with added architectural features and environmental enhancements is less than the cost to build a traditional plant with permanently embedded specialty equipment.
2. The cost of portable, self-contained modules with all production-related equipment falls under equipment budget, NOT under the capital budget.
3. Investment in modules may qualify for equipment-related financial incentives and tax rebates offered by state and local governments to offset the cost of new modules.
4. TOTAL cost to build a more flexible facility—including modules—could wind up lower than the cost to build a traditional facility.

As Patelski notes above, attempting to pinpoint a valid per square foot cost to build a facility similar to the Design Team's prototype is difficult, given the challenge in projecting future cost for key features such as next-generation utilities and lighter-weight construction materials, or the estimated cost of the self-contained modules themselves.

Savings accrue at the point of conversion

Savings begin to mount after the presumed initial lifecyle of the facility is complete — about 20 years from build-out. While the book value of the facility at this point may be calculated at zero for tax purposes, in reality, the flexibly built facility retains significant worth.

After this time period, the ease of conversion into other uses—and the cost-effectiveness—becomes crystal clear. If the owner is considering a sale, the value of this flexibility is shown in how quickly the facility—basically an attractive but plain vanilla shell—sells.

Compare this anticipated quick turn with the challenges associated with trying to sell a plant heavily encumbered with permanent specialty equipment. Such a plant may sit idle for months upon months—creating a burden of carrying costs for the owners.

"In the event that the building becomes vacant, a flexible design would shorten the amount of time it would take to locate a new occupant," notes Stephen Kozarits, a senior vice president in Transwestern's Industrial Practice Group. "Special purpose buildings can sit vacant for years. A building that appeals to a broader segment of the market might only sit vacant for a few months."

Kozarits notes that depending on the location, in today's dollars, such carrying costs—taxes, insurance, maintenance, security—could run as high as $4 -$5 dollars per square foot per year. Depending on the size of the facility, carrying costs could top $1 million a year.

"The real financial value of this flexible approach is in the amount of savings an owner would achieve from a reduced vacancy standpoint," he says.

If the same owner retains the building for different uses, the ease of repurposing contrasts starkly with the time and cost of site selection, design, permitting, and construction of a greenfield facility in a different location.

"THE REAL FINANCIAL VALUE OF THIS FLEXIBLE APPROACH IS IN THE AMOUNT OF SAVINGS AN OWNER WOULD ACHIEVE FROM A REDUCED VACANCY STANDPOINT."

— *Stephen Kozarits*,

Senior Vice President Industrial Practice Group Transwestern

RECOMMENDATIONS

Looking ahead, it is expected that an increasingly compelling business case for weaving flexibility into the core of all manufacturing facilities will drive widespread adoption of flexible principles and concepts. However, current policy and practice often conspire against the kind of investments being promoted in this paper. Addressing the issues requires efforts on multiple fronts.

Financial, accounting & regulatory level

- Review of regulatory, tax and financial reporting requirements to remove potential disincentives for long-term ownership
- Review of regulatory, tax and financial reporting requirements to identify ways to encourage increased facilities flexibility

Community & economic development level

- Outreach to communities, as well as state and local officials to change perceptions about industrial facilities and educate them on the value of encouraging building with increased flexibility:
  - Support locations in closer proximity to densely populated customer markets
  - Enable larger sites for co-located activities
  - Encourage attractive design and landscaping guidelines
- Guidance to policymakers and economic developers on tools to support and incentivize increased flexibility:
  - Enterprise zones
  - Industrial bonds
  - Municipal grants
  - Tax abatements for equipment upgrades
  - Public-private partnerships for infrastructure improvements and advanced skills training
- Review of business attraction and retention incentives to:
  - Encourage building with increased flexibility, sustainability, energy efficiency and visual appeal
  - Ensure alignment with the changing workforce needs of increasingly automated manufacturing enterprises
  - Help offset the cost of modular conversion/equipment upgrades

Corporate level

- Reconsider approach to internal rates of return on projects and how to achieve ROI improvements by doubling, tripling, or quadrupling the estimated lifecycle of the building—or increasing the building's value at resale, also taking into account the reduced cost to repurpose and reduced time to sale
- Improve communication and collaboration to reduce the disconnects between finance, the capital investment, real estate portfolio, and facilities management

AREAS FOR FUTURE EXPLORATION & RESEARCH

There are cost-estimating challenges associated with a longer-term approach to facilities design, construction, and operation, to be sure. The development of a viable analytical model that looks at lifecycle costs extended for a longer term could help address some of these issues. This would be a valuable contribution to the knowledge base on industrial facilities construction and operation. We also believe that a more thorough review of the incentives landscape could yield hidden opportunities to encourage building for the longer term.

As stated earlier, this paper is the first in a series of IAMC/SIOR papers to explore the universe of flexible design possibilities for industrial facilities. A final, capstone paper will consolidate the findings from the three design white papers while breaking new ground with additional assessment of the cost issues and providing a more detailed discussion of the economic development approaches and policy prescriptions that would support building the industrial facilities of the future with increased flexibility.

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APPENDIX: MEET THE FOOD PROCESSING DESIGN TEAM

Burns & McDonnell

Burns & McDonnell is a company of more than 5,000 engineers, architects, construction professionals, scientists, consultants and entrepreneurs with offices across the country and throughout the world. Burns & McDonnell is 100 percent employee-owned and is proud to be No. 15 on FORTUNE's 2015 list of 100 Best Companies to Work For. For more information, visit burnsmcd.com.

Wayne Young, design team co-lead, is a project manager within Burns & McDonnell's Environmental Studies and Permitting Division, Stakeholder Management Solutions Group. He has more than 20 years of experience in comprehensive land management, public involvement, and outreach services and the associated systems, protocols, and best practices. He has managed numerous land acquisition projects for utility companies in Indiana, Maine, Connecticut, New Jersey and Oklahoma.

Mark Huettner received his BSAS and MA from the University of Nebraska. He has 27 years of experience in project design and management. Mark has designed a variety of building types including schools, sports venues, office buildings, recreation facilities, libraries, several laboratory buildings and most recently industrial and manufacturing facilities primarily for the food industry. Mark has been with Burns & McDonnell for 8 years. Mark says, "How we plan our buildings has the power to influence and improve our quality of life. I believe that good design can enhance our happiness, health and productivity.

Matthew Stagemeyer received his Bachelor of Science in Mechanical Engineering and a Masters in Engineering Mechanics from the University of Nebraska. He has 11 years of experience in research and engineering consulting. Matt Stagemeyer' s responsibilities within Burns & McDonnell as a mechanical and project engineer with the Food & Consumer Products Group have included: coordinating engineering efforts by multiple disciplines across multiple project sites, creating and executing mechanical contracts, designing and installing both experimental/ prototype and well-established production equipment, and maintaining client relations with regard to project development and execution.

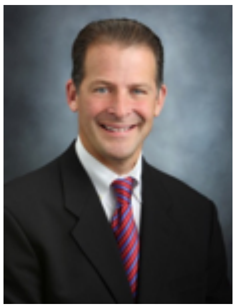
David Findlay is a project manager and senior architect with Burns & McDonnell Global Facilities – Manufacturing Group, with 22 years' experience. As a project manager and senior architect, David is the primary liaison with the client and coordinates all aspects of a given project – design, engineering, purchasing, and construction, as well as scheduling, accounting and estimating – toward meeting the needs of the client. David's food work includes enrobed novelty ice cream, seasonings, salad dressings, snack foods, beverage, bakery, brewery, distillery, and yeast production. He is architect of record on the world's largest french fry plant, and has significant projects at the world's second largest ice cream plant. His work has contributed to two major successful North American product rollouts of new products into the marketplace, and several other major rollouts in related fields.

Mal Warrick joined Burns & McDonnell in May of 2014 and has made significant contributions for the Food & Consumer Products group within the Process & Industrial Global Practice. As a business development manager, he is leading the development of design-build engagements with several new and existing clients. He also has led the evolution and utilization of pre-capital business consulting for his team. Several master planning and optimization efforts have already been conducted to enable clear execution paths for clients needing clarity for capital investment strategies.

Mal graduated with a Bachelor of Science degree in Industrial Engineering from Iowa State University in 1982. Mal's 32 years of experience includes 22 years with Procter & Gamble in plant operations, marketing and strategic planning. In addition, he has held corporate supply chain and director positions with Hallmark Cards and MGP Ingredients.

Ghafari Associates LLC

Ghafari Associates is a leading architecture, engineering, consulting and construction services organization with a long-standing history of client focus, quality design and technological innovation. With offices in North and South America, the Middle East and India, Ghafari serves a diverse client base across a variety of technically intensive market sectors. The firm distinguishes itself as an operations-focused practice with experienced management leadership, expert technical resources and an impressive portfolio of projects. Focus is on an integrated approach to deliver solutions that synergize building systems and operations.



John Patelski, PE, LEED AP, co-design team lead, is Executive Vice President with Ghafari Associates, LLC. With a career spanning 35 years, John has a wealth of experience in strategic consulting, operational evaluation, facility design, engineering and construction services for a variety of industrial, commercial, institutional, science and technology projects. He serves as overall account executive and principal-in-charge for several of Ghafari's key accounts. John is responsible for expanding Ghafari's services in new strategic markets, with special emphasis on the food and energy sectors.

Kevin Angell, AIA, is a project manager and architect with more than 25 years of experience. His responsibilities at Ghafari include code review and analysis, programming, construction document coordination and production, as well as construction administration. Additionally, he has helped develop and maintain Ghafari's quality assurance policies and procedures. Kevin's project experience includes academic, aviation, commercial, food and media facilities.

Kevin earned a Bachelor of Architecture from the University of Illinois and is a licensed architect in the state of Illinois. While at Ghafari, Kevin has worked on a variety of food projects, including a bacon processing plant, a chicken processing plant in Central America and a large flight kitchen / catering facility in the Middle East.

J. Peter Clark, PhD, P.E., CFS, serves as senior process engineering specialist at Ghafari. He has more than 45 years of experience, most recently working as an independent consultant. Dr. Clark began his career as a research engineer for the Agricultural Research Service as part of the U.S. Department of Agriculture. His past positions include Vice President, Technology for Fluor Daniel; Senior Vice President, Process Technology and President, Epstein Process Engineering for A. Epstein and Sons, Inc.; Director of R & D for ITT Continental Baking Company; and Associate Professor of Chemical Engineering at Virginia Tech.

In his role as a consulting engineer, Dr. Clark led groups that designed and built award-winning food plants, including the world's largest ice cream plant at the time, which also was Food Engineering's Food Plant of the Year; a major pet food plant that was runner up as Food Plant of the Year; and two significant breakfast cereal plants; as well as numerous small projects in numerous areas of the food industry.

Dr. Clark earned a bachelor of science in chemical engineering from the University of Notre Dame as well as a PhD from the University of California, Berkeley. He is the author or editor of eight books and more than forty journal articles, and has written a monthly column on food processing for Food Technology magazine for the past 12 years. Dr. Clark is a registered professional engineer in the states of Virginia and Illinois and a Certified Food Scientist. He is a Fellow of both the American Institute of Chemical Engineers and the Institute of Food Technologists.

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