



**THE
FOOD FACTORY
OF THE FUTURE**

**ADVANCED MANUFACTURING TECHNOLOGY WORKSHOP:
TRANSFORMING THE FOOD FACTORY TO THE CULINARY CAMPUS FOR
THE 21ST/22ND CENTURIES
18 – 19 May 2015
LINCOLN, NEBRASKA**

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OVERVIEW

On 18 – 19 May 2015, a workshop was convened at the University of Nebraska – Lincoln as a first step in creating a national public-private partnership focusing on improving the quality, volume, safety and security of food through advanced manufacturing. The shared vision is to employ state-of-the-art advanced manufacturing methodologies along the entire supply chain to minimize contamination risk and associated sanitation costs, enhance security, and make more nutritious food at higher volumes and lower cost. In so doing, this partnership will not only transform the food manufacturing industry, it will enhance global security and stability through a plentiful, sustainable food supply for a growing world population.

Close to fifty companies, manufacturing partnerships, state and regional economic development entities and universities were present. The majority were executives from both major food manufacturing companies as well as companies that supplied equipment to those food manufacturers. The workshop opened with a plenary talk by former Secretary of State Madeleine Albright followed by a series of panel discussions and dialogues that began to identify and highly technology challenges, sensor and data analytics/management requirements, workforce needs and public policy and education challenges.

Key outcomes of the workshop was a shared understanding that:

- i) the transformation of food manufacturing is a national/global imperative,
- ii) there is broad interest and support for building a public private partnership to enable and accelerate this transformation,
- iii) there will be a concomitant transformation and growth of the advanced food manufacturing workforce to one that is highly skilled and well paid,
- iv) education and public policy around food quality and safety must be an integral part of this enterprise.

To the last point, there was consensus that the term ‘culinary campus’ better describes the goal of this initiative and does not carry the negative, impersonal connotations of ‘food factory’. Indeed this undertaking can be captured in the simple phrase, “*transforming food factories into culinary campuses*”.

The participants agreed that the immediate next step is an industry-wide survey to assess the state of the industry and to identify key technology gaps in common areas of interest. A follow-up workshop, tentatively in early 2016, would then be convened to begin the process of articulating a technology roadmap for the partnership.

The body of this report contains summary highlights of presentations and discussions in the workshop. It is preceded by a brief synopsis of the forming document that preceded the workshop. A detailed listing of conclusions/outcomes of this event along with thoughts on next steps close this report.

BACKGROUND AND CONTEXT

The genesis of the Food Factory of the Future workshop was a white paper¹ identifying food manufacturing as an advanced manufacturing technology industry. Approximately 80% of the workshop participants provided letters of support for that concept document. One of the tenets of the white paper was that, in many respects, the manufacturing challenges in food are far more complex than what is traditionally thought of as advanced manufacturing because the raw materials and finished products have highly variable dimensions and properties that change with time and environmental conditions. And, at the same time, addressing the challenges of food manufacturing are critically important because of two grand challenges of national and global importance:

- ensuring a stable and sustainable supply of affordable, safe, nutritious food not only for the US, but for the world, and
- equipping and empowering U.S. food manufacturing companies, as well as the US companies that make food manufacturing equipment, to establish highly competitive manufacturing plants around the world.

The pathway to making food safer, better, more affordable and more plentiful, lies in automating the food manufacturing industry. Automated production lines will dramatically reduce sanitation and operating costs; potentially in excess of ~\$5B annually industry-wide. These cost savings can be capitalized to further automate food production beyond the initial investments, to build new state-of-the-art automated food manufacturing plants around the world, and, in so doing, create a technologically-skilled, well-paid workforce at least as large as the current, labor-intensive, low-income labor force currently employed across the industry. This will be a revolutionary transformation with societal implications on par with the automation revolutions that led to commoditized cars and consumer electronics.

Transforming the industry requires strategies to transcend seven major technology barriers:

- 1) upgrading labor-intensive food product production lines using reconfigurable automation and control equipment,
- 2) developing anti-microbial materials or coatings to make food contact surfaces hostile to contaminants,
- 3) deploying sensors and big data analytics to automate manufacturing and sanitation,
- 4) preparing a highly skilled, technologically literate food manufacturing workforce,
- 5) establishing manufacturing standards around food automation integrated with safety standards,
- 6) exploring long-range research and development opportunities related to new food sources and manufacturing processes,
- 7) conducting an integrated public policy and education campaign focused on food quality, safety, and manufacturing.

On 18 – 19 May 2015, leaders from nearly fifty industries, manufacturing consortia, governmental organizations and universities came together to begin a face-to-face dialogue around the process needed to create a public-private partnership to transform food manufacturing. The first day of the workshop consisted primarily of panel discussions preceded by an opening plenary talk delivered by former Secretary of State Madeleine Albright. The second day featured an introduction by Nebraska's Lieutenant Governor Michael Foley, breakout discussion groups around the key technology barriers and a culminating plenary discussion on next steps.

SESSION 1: KEYNOTE ADDRESS

SPEAKER – MADELEINE ALBRIGHT (FORMER SECRETARY OF STATE)

SESSION MODERATOR – TIMOTHY WEI (UNIVERSITY OF NEBRASKA – LINCOLN)

Secretary Albright opened the workshop with a brilliant and thoughtful overview of the social, political and technological challenges of safely and effectively feeding the world's growing population. Her ongoing roles in food security on a global scale are a testament to her personal commitment to this problem. She pointed out that, in time, as the global population continues to increase, demands on the food supply will also increase. And that it is ultimately poor nutrition that kills so many children around the world.

For many years, the United States, along with the developed countries of the world, have already had the capacity to feed the world. Secretary Albright held everyone to a higher calling. Companies, she said, quoting Benjamin Franklin, need to “do well by doing good”. Governments and landowners need to ensure fair access to water, land and fertilizer for small farmers. She pointed out that many in the world still do not have legal documentation or legal title to their land; making it difficult, if not impossible, for the poor to escape poverty. She emphasized that governments also need to create clear regulatory environments that allow agricultural innovations to increase yield. She used as an example the misinformation used to create a public backlash against genuine and effective advances such as genetically modified crops.

As she concluded, she pointed out that public private partnerships, such as the one being contemplated at this workshop, will be essential to solving the problem of world hunger. She noted that, by virtue of the fact that food sources are predominantly grown locally, food manufacturing solutions must be developed locally but rooted within a global perspective.

In the Q&A session following her presentation, Secretary Albright expanded on a number of these themes. She pointed out that the politics of food is difficult and that political and economic development go hand in hand. She argued that water is a critical issue with the very real potential for armed conflicts. She listed five factors around which countries make foreign policy decisions: i) objective (*e.g.* location, demographics, *etc.*), ii) subjective (*i.e.* the country's self image), iii) type of government, iv) bureaucratic politics (as reflected in government budgets) and v) the role of the individual in that society.

In this context, Dr. Albright challenged global companies to intentionally consider how they engage locally. They need to pay attention to local needs, resources; that it is important to understand local conditions and develop partners. Small to medium sized companies need to also be involved. She stressed that there is great value in sharing information (and noted that the media carries a responsibility in this area to educate and inform and not be so focused on ratings). Finally, she emphasized that it is important to work with women in other countries to help them develop businesses, and to understand land as a resource; who owns it and how it's used.

In brief, Secretary Albright was highly supportive of the creation of a public-private partnership targeted at feeding a growing and hungry population. She highlighted the complexities of a successful enterprise, not only from a technological perspective, but from the integration of myriad socio-political implications and issues. The principle challenge she put forward to the group will be clearly articulating and strategically addressing the intersections of as many constituencies as possible.

SESSION 2: THE FOOD SUPPLY EQUATION

PANELISTS – STEPHEN BAENZIGER (UNIVERSITY OF NEBRASKA - LINCOLN), NICK BROZOVIC (DAUGHTERY WATER FOR FOOD INSTITUTE), BRAD MORGAN (PERFORMANCE FOOD GROUP)

SESSION MODERATOR – RONNIE GREEN (UNIVERSITY OF NEBRASKA – LINCOLN)

The next step in the workshop was to examine food manufacturing from a systemic supply chain perspective, *‘from farm to fork’*. Ronnie Green set the tone of the panel by identifying three focus areas: *a)* agricultural production of the inputs entering into the food manufacturing industries, *b)* management and sustainability of the natural resources required for food production, and *c)* integration of these inputs into the market and on to the consumer.

One of the constant and critical challenges is acquisition, transfer and analysis of data along the supply chain. Steve Baenziger pointed out the high degree of variability in crops from location to location and from season to season. He pointed out that hamburger buns for MacDonaldis are produced at a rate of 36,000 buns per hour with an expectation that every bun look, feel and taste the same. The way consistency is achieved, he said, is through thorough mixing of wheat from a wide variety of locations.

But how does the baker assure the blend of wheat remains invariant indefinitely? And then how does one troubleshoot problems, *e.g.* contaminants from a single farm? There are both agricultural as well as technological components to this problem. In the context of this workshop, the technological challenge is recognizing that both food production/processing and affiliated data must be managed with an eye toward what will happen and what will be needed along the entire supply chain.

This systems level perspective is also important in terms of resource utilization and management. Nick Brozovic spoke specifically to the intensive water requirements in everything from growing food to sanitation of food manufacturing facilities. Not only are there conservation and efficiency considerations, water security is a tremendous challenge. These considerations, he continued, point to concomitant requirements for public policy, regulation and sound science applied to all aspects of safe, sustainable use of resources.

Brad Morgan spoke from his background in animal production. He continued on the theme of public awareness and engagement, specifically in the context of assuring the public that not only is food and food production currently very safe, wholesome and of high quality, but that it will increasingly improve into the future. This will require transforming the industry through automation. But it will require the industry to intentionally and continually assure the public that the transformation is safe, sustainable, and ultimately in the best interest of the consumer.

Themes that arose in the panel discussion and ensuing Q&A included the need for the industry to be very innovative in solving problems, proactively considering global impacts, ensuring public understanding and engagement.

In summary, from crops to livestock, from farm to fork, there will have to be dramatic technological innovations to how we grow and process food and how we manage resources. This will require systems level perspectives at local levels along the entire supply chain and accompanying data tracking and analytics. But all of this will be for naught if the industry does not proactively and effectively educate and engage the public in understanding that transformative advances along the entire supply chain are explicitly being done to further improve safety, quality and security.

SESSION 3: FOOD MANUFACTURING INDUSTRY

PANELISTS – CHUCK APULCHE (ALPS CONSULTING), MATTHEW CHANG (HASKELL), JIM PRUNESTI (CAMPBELL), MIKE ROBACH (CARGILL), ROLAND UDENZE (HASKELL), CRAIG WEISS (CONAGRA FOODS), MARY WONDOLOWSKI (OPS UNLEASHED)

SESSION MODERATOR – JEFF KORENGEL (CONAGRA FOODS)

From the entire food supply chain, the workshop was then focused at food manufacturers. The broad question addressed in this panel was what technology gaps need be transcended in order to feed a growing global population in a safe, sustainable, affordable and efficient way. Jeff Korengel started the session by highlighting the tremendous advances the industry has made over the past fifty to one hundred years. In North America, the cost of food has dropped from ~22% of disposable household income to <6%. And food related diseases have been dramatically decreased or eliminated. He pointed out that, in addition to a growing global population, there are emerging challenges along the supply chain including climate change, and the competing demand for sustainable fuels. As such, there is still much that needs to be done across the industry.

The panel addressed a series of questions including technology gaps associated with sanitation and safety, innovation opportunities in food production and processing, workforce and consumer engagement as advanced manufacturing methodologies are integrated with food production.

A number of panelists pointed out the importance of developing dry technologies for cleaning, both from a water utilization perspective as well as preventing biocontaminant proliferation. Matthew Chang said that many key sanitation technologies exist today, but the implementation costs are currently prohibitive. Mike Robach foreshadowed a discussion about automation and robotics by positing that human contact with food needs to be limited, if not eliminated, as a major step in improving food safety.

More broadly, the panel noted that innovation opportunities exist across manufacturing industries. Roland Udenze recommended scanning across the aviation and pharmaceutical industries, for example, for inspiration and opportunities. Chuck Apulche commented that transformational change is a ‘great unknown’; change is not part of the industry culture. He further observed that food companies in countries that are not so driven by ROI are far more flexible and innovative.

The need for expanded automation and robotics was discussed not just for sanitation and safety, but also for consistency of product. Craig Weiss stated that the food industry uses robots far less than other industries. Jim Prunesti warned that the efficacy of robots will be realized only when they replicate the complex motions of the human hand. Mary Wondolowski argued that the use of robots will need to be really revolutionary, that robots will need to be very flexible, and that they may well need to operate safely in close proximity to humans.

Discussions on automation and innovation evolved to thoughts on workforce and consumer acceptance. Challenges associated with attracting and retaining an advanced manufacturing workforce were raised. Thoughts were expressed about how different the work environment will be with operators even possibly operating multiple lines in different plants. This led to conversation about the importance of engaging the consumer through the manufacturing transformation. In this era of ‘real food’, there is a perception that handmade is intrinsically better than machine made. This is contrary to the enhanced safety, security, quality and affordability associated with automated production. Roland Udenze perhaps captured the essence of the session when he said that the industry must cater to the needs and perceptions of the consumer, worker and farmer of the future.

SESSION 4: TECHNOLOGY CHALLENGES

PANELISTS – JOHN ALHBORN (ROCKWELL AUTOMATION), JIM COSTA (SSBA), THERESA KOTANCHEK (EVOLVED ANALYTICS), MIKE MCCARTHY (UNIVERSITY OF CALIFORNIA - DAVIS), STEVE ROYCE (AGILENT), ROGER STANCLIFF (KEYSIGHT TECHNOLOGIES), ROLAND UDENZE (HASKELL)
SESSION MODERATOR – TOM KURFESS (GEORGIA TECH)

The workshop was structured to next capture the thoughts, reactions and responses from technology suppliers to the insights of the preceding panel. They followed on the theme of the preceding session by identifying technology barriers to transforming food production into an advanced manufacturing industry. The session moderator, Tom Kurfess, opened by pointing out that ultimately, the key challenges principally lie in the areas of i) inexpensive, low-cost sensing, ii) the big data storage, management and analytics, and iii) developing simulation tools and methodologies to efficiently model and predict the performance of new production lines and processes.

John Ahlborn provided an overview of manufacturing world wide. He noted that there is a new emerging middle class and that China, Germany and the US are the major manufacturing growth countries. While increasing productivity, slow wage growth and energy cost advantages have helped the US become more cost competitive, challenges include: aging infrastructure, lack of systems integration, loss of intellectual property and \$20B annually in unscheduled downtime.

Jim Costa showed a video of a 3-D food factory simulation as a lead in to the need for incorporating big data in warehousing and inventory control. He emphasized the need for focus on worker safety in designing future facilities, and then went on to the need for low-cost sensors. Roland Udenze built on these themes. He stressed leveraging advances in other industries, *e.g.* wearable robotics and 3-D printing. He discussed how limitations in land use will drive the design of future facilities. He closed by emphasizing the importance of perception, and the need to intentionally connect the entire food supply chain back to the farm in the minds of the consumer.

A context for big data in food manufacturing was provided by Theresa Kotancheck. She defined data science in terms of extracting knowledge from data and exploring relationships between people and/or things. Key questions include: which data are useful/target rich? easy to reach? transformative? She pointed out that 70% of content is being created by individuals, but that enterprises have contact with, and therefore liability and responsibility for, 85%. This creates risk at the corporate level. But, quoting Mike Loukides, she said that ‘the future belongs to those who translate data into product’.

Mike McCarthy focused his comments on sensors from the perspectives of safety, quality and consistency. He observed that all industries he talked to seemed to think that *they* were the ones who were behind. In food, he argued that sensors for personalization of food would be critically important. Steve Royce spoke in greater detail about sensors. He hypothesized that current work on miniaturization today may lead to *in situ* real time measurements in the future. Applications of sensor technologies specifically to wine were highlighted by Roger Stancliff. Wireless transmission of sensor data is critical for real time acquisition and analytics.

In the Q&A session, data management, security, and protection of intellectual property were raised as major concerns. In short, in addition to automation, sensors and efficient use of the generated data will be at the core of future technology innovations in the food industry. Codes and standards for all of these new technologies will also be required. Leveraging technological advances across all industry sectors will advantage everyone.

SESSION 5: DINNER ADDRESS

SPEAKER – DEAN BARTLES (DIGITAL MANUFACTURING DESIGN INNOVATION INSTITUTE)

Through the course of the workshop's first day, the focus progressively narrowed from the broad global necessity for advanced food production to the enabling equipment and technologies that make the food. After dinner, Dean Bartles provided a case study on the Digital Manufacturing Design Innovation Institute (DMDII), one of the Manufacturing Innovation Institutes (MII) comprising the National Network for Manufacturing Innovation (NNMI). He provided a brief history of DMDII and talked about organizational challenges such as partnership agreements, managing IP, and identification and execution of projects. This provided attendees with insights and a model for forming a public-private partnership around food manufacturing.

SESSION 6: BREAKFAST ADDRESSES

SPEAKERS – MIKE FOLEY (LT. GOVERNOR OF NEBRASKA)

DAN CURRAN (NEBRASKA DEPARTMENT OF ECONOMIC DEVELOPMENT)

The morning of the second day was kicked off by Lt. Gov. Mike Foley and Dan Curran, Director of Business Development for the Nebraska Department of Economic Development. They both provided warm welcomes to the workshop participants and highlighted the aspirations for Nebraska. Recruiting/developing a skilled workforce and high paying jobs to the State is a top priority of the newly elected administration. Both speakers encouraged the participants to pursue this initiative and offered their support wherever possible.

SESSION 6A: INNOVATION

SPEAKERS – LAUREN SHIMEK (IDEO), TRACY BAKER (MATTSON), JOHN BERNADEN (ROCKWELL AUTOMATION)

Having had a more technology focused discussion on the first day, this panel the broad issue of innovation. Lauren Shimek identified six themes in food innovation:

- 1) ***the new fresh*** – although foods are fresh, new technologies are making them fresher,
- 2) ***transparency, sourcing, animal welfare*** – people want to know where their food comes from,
- 3) ***ingredient label renovation*** – people want not just nutritional information, but listings of ingredients that are recognizable; this may eliminate common ingredients in the future,
- 4) ***21st century grocery shopping*** – businesses like Amazon are entering the grocery market with on-line ordering and quick delivery,
- 5) ***hidden cost of food waste*** – there is a need to define the true shelf life of an item and to figure out how to market and sell 'ugly' foods,
- 6) ***food science for greater good*** – companies are marketing food around social themes, not just taste.

She closed with the notion that there is a bias against food that is 'engineered' or 'processed'. As such, there is a need to link technological advances with story telling about the food. To solidify the point, she closed with the following statement, "Wine is made in a winery. Beer is made in a brewery. Why is food made in a factory?"

Tracy Baker followed in the same vein. He, however, viewed the inspirations for innovation in terms of: ***lifestyle, flavor, form factor, business model, industry shifts***, and others. He talked about

the concept of ‘er’ eating (*e.g.* bolder, deeper spicier, darker, *etc.*) He highlighted some interesting products and services that are currently impacting the industry in a transformative way. He talked about Conscious Box that sends products monthly to your home; Fresh Realm which will provide new product from farm to home with seven days of food in a refrigerated box. He was concerned about the trend toward salad vending machines because of the potential for food safety. Following on the theme of story telling, he stressed how bloggers and self-made ‘experts’ with their false claims and faulty science have attracted large followings by capturing sectors of the public with well-crafted stories.

Another theme that had been resonating throughout the first day was approaching transformation along the entire supply chain. This was revisited more extensively by John Bernaden. He emphasized that tremendous efficiencies and savings can be realized through effective transfer and utilization of data along that supply chain. He referred to the concept of an integrated supply chain as the ‘*connected enterprise*’. The benefits, he said, were: faster time to market, lower total cost of ownership, improved asset utilization and optimization, and enterprise management.

Bringing this to fruition, he argued, requires a public-private partnership with a new, shared infrastructure to connect and converge smart manufacturing processes. A new supply chain infrastructure would also be required which, when automated, would include real-time data exchange, and tightly-coupled, fault-tolerant connections with end-to-end ethernet communications.

This group of presentations gave participants an opportunity to think about innovation from very divergent perspectives, through the eyes of food scientists innovating on product and delivery, and through the eyes of the engineer who builds the equipment with which food is produced. But the recurring themes of technology, data, sensors, consumers, integration, speed, quality and purity were universally present.

SESSION 7: BREAKOUTS

A key feature of this workshop that cannot be adequately reflected in this report was the richness of the discussions both during the Q&A sessions after every presentation/panel, and between sessions. Building on these conversations and the quality, breadth and depth of the speakers’ insights, a set of breakout sessions was convened to explore specific aspects of the proposed public-private partnership. Topic areas included:

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|--|--|
| i) automation and control, | iv) codes and standards, |
| ii) sensors and big data analytics, | v) workforce, |
| iii) antimicrobial materials and coatings, | vi) education, public policy, and marketing. |

The discussions in each group were intended more to foreshadow future detailed roadmapping dialogues, and not to be conclusive in and of themselves. To that end, participants were randomly seeded into groups rather than intentionally placed. What may have been lost in expertise, was hopefully more than made up for in diversity of viewpoints. Brief synopses of the group discussions appear on the following pages.

SESSION 7.1: AUTOMATION AND CONTROLS

The imperative of transforming the food industry through automation reverberated throughout the workshop. The breakout group that discussed specific technology gaps took a very systemic perspective of the problem. They first noted that an industry-wide culture change needed to oc-

cur in order to embrace automation. There needs to be a clear value proposition with an understanding of the opportunity cost for not automating. And, they determined, there needs to be comprehensive modeling of processes along the entire supply chain from farm to fork.

The technology challenges the group raised were not so much about automation technologies, as much as the need for inexpensive sensors that could withstand the food production environments. These would be essential for real-time decision-making. Data acquisition, high speed processing and analysis are, of course, the natural corollary to sensors. The group recognized that codes and standards for sensors and data would have to be developed. Finally, the group noted that automation should be applied to cleaning and material handling as well, and not just limited to processing/production.

SESSION 7.2: BIG DATA AND SENSORS

As noted above, development of sensors and the analytics to process and use the sensor data are central to automating food manufacturing. This group addressed particular aspects of this component of the food manufacturing transformation. They identified the need for data from the perspectives of overall system efficiency, of plant automation, of safety, of packaging, and of product/process design. Concomitant with these challenges will be ensuring seamless data integration and security along the supply chain.

Much of what was discussed in this group aligned with conversations that had organically emerged throughout the workshop. This is a testament to how important big data and sensors are to the enterprise. The group expanded on these themes and raised the issues of equipping workers of the future for successful careers in the next generation food facility. They also raised the possibility for the creation of agile small and mid-tier companies creating innovation co-ops.

SESSION 7.3: ANTIMICROBIAL MATERIALS AND COATINGS

This group discussed the broader issue of all materials and coatings in food manufacturing plants. They recognized significant improvements ranging from foams and insulating materials to non-slip safety flooring. They identified limitations which are impeding progress. These included the lack of connectivity across industries and disconnects with regulatory agencies. Regarding the latter, the example cited was that a certain antimicrobial coating was rejected by regulators because it would not survive the cleaning processes; not recognizing that the introduction of the coating would lead to changes in cleaning.

These challenges were recast as opportunities. It was recommended that the food industry, particularly the research and development arms, engage across other industry sectors and societies. Aerospace and the American Society of Mechanical Engineers were given as examples. But integration with industries with similar challenges and needs, like water and medical, would be invaluable. The need for closer connection with academic materials science groups was identified, specifically with a focus on antimicrobial materials and coatings. Finally, there needs to be better engagement and collaboration with the regulatory bodies in the connected domain of materials and coatings versus the evolution of cleaning technologies.

SESSION 7.4: WORKFORCE

One of the greatest challenges to transforming the food industry is transforming the workforce. Specifically, how does the industry successfully transform the workforce from a labor intensive force working on the production floor, to a technically trained force that manages equipment and

processes from remote locations. It was pointed out that in automation transformations that have occurred in other industries, *the net number of jobs actually increased* by virtue of the fact that higher productivity at lower cost enabled companies to open additional facilities and production lines. So while a specific plant may have seen a reduction in workers, this was more than made up for in the creation of new facilities and new jobs.

The group articulated a number of targeted considerations for the new workforce. Safety, of course, must continue to be of paramount importance, particularly with automated machinery interfacing with human workers. Competitive salaries, continuing education opportunities, profit sharing and benefits plans were among the considerations raised. In addition, the importance of training, not just in the operation of sophisticated automated equipment, but also in terms of hygiene, safety, security and environmental responsibility are going to be critical.

SESSION 7.5: CODES AND STANDARDS

The paradox of duplication of and lack of regulatory oversight for the food production facility of the future was one of the key points raised in this group's discussions. Oversight by at least eight governmental agencies with regulations by USDA and FDA, for example, often conflicting, is problematic for the industry. It becomes even more challenging because the regulations address existing processes, but do not sufficiently flexible to accommodate innovation. This is exacerbated by the lack of global standards, or even common definitions (e.g. 'organic'). They argued that, first and foremost, standards must be functional rather than specified. This is the only way that they can keep pace with much needed innovation.

This group then focused on some specific areas where codes and standards are needed. They pointed to needs for standards in hygiene, human interface with automation, shelf labeling and testing methodologies. The need for standards in cyber security, virtual audits and traceability were also raised. The group questioned whether it was possible to standardize training, and if effectiveness of training could be assessed; and whether standards that support global social responsibility could be articulated. Finally, the group pointed out that without the reduction or consolidation of regulatory bodies, small to medium sized manufacturing companies would not be able to engage in the food manufacturing transformation.

SESSION 7.6: EDUCATION, PUBLIC POLICY AND MARKETING

Another of the greatest challenges to transforming the food industry (*cf* §7.4) is managing the public understanding and perceptions around food. Concern was voiced throughout the workshop regarding the strength of voice arrayed against 'processed' foods and the perceived dangers of 'technology' applied to food. Yet the public inability to connect the technological innovations over the past century which allows us to buy food and immediately eat it without even considering the possibility of risk.

The group embraced Lauren Shimek's idea of storytelling; that this should be done proactively from K-6 education and on to the mass media. The core of the story is that the industry is singularly focused on making high quality, nutritious, *safe* food. Another important element of the story is that food security (through automation and other advanced manufacturing technologies) directly translates to global security through the reduction/elimination of starvation. Engaging policy influencing leaders from both the USDA *and* the FDA in this consortium would be an important step in advancing this initiative. And partnering with colleagues in developing countries would be a great way of building positive, peaceful alliances around the world.

SESSION 8: NEXT STEPS AND CLOSURE

The final element of the workshop was an open dialogue by all participants about interest in creating, and possible structure of, a public-private partnership that would transform food processing and production into an advanced manufacturing industry. There was unanimous agreement to continue the dialogue in that direction.

A discussion then followed as to the nature of such a partnership. Creating a stand-alone MII was one possibility; this is a high risk, high reward approach highly dependent upon the timing and variability of federal funding. Another opportunity was to join as a test bed in an ongoing smart manufacturing consortium effort being led through Rockwell Automation.

Regardless of the success in soliciting federal funding, it was agreed that state departments of economic development will need to be key partners in this enterprise. Indeed federal funding will only last approximately five years after which the expectation is that the institute will be self-supporting with industry and state contributions. In that vein, it was agreed that the creation of a private membership structure should be explored as an earlier next step.

Specific findings/conclusions from this workshop included:

- There is a strong interest in exploring the creation of a public-private partnership in the advanced manufacturing of food.
- In order to maximize impact and success, the partnership must be organized around pre-competitive technologies and methodologies.
- The consortium needs to be structured around the entire supply chain, not just that which occurs within the ‘four factory walls’.
- Efforts of the public-private partnership should be solely focused on transformational, not incremental, change.
- There are actually eight key technology areas that need to be addressed:
 - 1) ***automation and control***
 - 2) ***big data and sensors***
 - 3) ***antimicrobial materials & coatings***
 - 4) ***processing***
 - 5) ***basic underlying research and development***
 - 6) ***workforce development***
 - 7) ***codes and standards***
 - 8) ***education, public-policy & marketing***

In the context of storytelling, there were two recommendations for immediate adoption. The first is that *we should refer to the ‘value chain’ instead of the ‘supply chain’*. The second is that *we should be planning to ‘create culinary campuses’ and not ‘food factories’*.

Finally, it was agreed that the group will reconvene in early 2016, with the possibility of additional potential partners. The focus of that meeting would be to prioritize the findings of the technology gaps survey, and to explore ways that a consortium can be organized to address those gaps. ***Specific action items in advance of that meeting were:***

- a) **prepare a final report for this workshop** (University of Nebraska) *completed*
- b) **prepare a video to accompany this report** (University of Nebraska) *~August 2015*
- c) **organize and deploy an industry-wide technology gaps survey** (University of Nebraska) *~August/September 2015*
- d) **engage Congressional delegations on the need for and importance of a food manufacturing coalition** (All) *~September 2015*
- e) **engage relevant state and local government partners** (All) *~September 2015*