

Automation for Bioprocessing and Bioproduction

Challenges and opportunities

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Agricultural mechanization has made remarkable contributions to production of food, materials, and fuels from biomass. Building on the success of agricultural mechanization, automation is expected to make a huge impact on the future agricultural and food system, as well as its related environmental issues. Automation is adding human-like intelligence to mechanized devices and systems. Automation deals with information processing and task execution related to a system's operation. The purpose of automation is to equip engineering systems with capabilities of perception, reasoning/learning, communication, and task planning/execution.

Perception involves obtaining awareness of surroundings, i.e. gathering, processing, and interpreting information about situations. Reasoning and learning are capabilities of logical deduction, mathematical analysis, heuristic inference, and experiential adaptation used to derive conclusions, make decisions, and issue instructions. Communication coordinates information flow from various sources to appropriate destinations. Task planning and execution are to effect device operations mainly for control activation and physical work.

Two major categories of automation are fixed automation and flexible automation. Fixed automation systems are cost-effective for mass production of standard items. Flexible automation offers the potential economic advantage of fixed automation while enabling response to varying make-to-order batch processes. Computers integrated with generic machine tools (such as robots) make automation systems flexible. The key feature of a flexible automation system is its ability to perform various tasks by changing mainly the software and requiring minimum hardware change. Commonly seen automation research and development topics include artificial intelligence, mechatronics, and systems integration. Design and implementation of components and processes of bioproduction systems requires interrelated knowledge in automation, biological culture, environment, and systems integration (i.e. the concept ACESYS). Automation frequently plays the role of systems integrator.

The specific challenges faced by automation in bioproduction are:

- making return on investment attractive
- optimizing systems by proper integration of automation, culture, and environment
- balancing fixed automation and flexible automation (i.e., identifying appropriate level of necessary machine intelligence)
- considering multiple use of machines or parts of machines
- dealing with the limited market demand and acceptance, and
- continuously improving research, development, and education capabilities.

On the other hand, the following opportunities do exist today:

- a higher technology readiness level
- past success of agricultural mechanization to be built upon
- excellent communication systems and platforms for sharing of technical advances
- an improved economic viability for automated systems
- better market acceptance, and
- potential spin-off technologies; and ability to facilitate implementation of emerging technologies.

This is an opportune and exciting time to further advance the positive impact that automation will bring to bioprocessing and bioproduction.

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