HONORING A DECADE OF BIOPROCESS

2012

BioProcess™ INTERNATIONAL AWARDS

THE FINALISTS

Welcome to the 2012 *BioProcess International* Awards — Honoring a Decade of BioProcess!

As we approached *BioProcess International's* tenth year of publication (2003–2012), we paused to reflect and gain a clear perspective on how scientific advancements, revolutionary new technologies, ground-breaking partnerships, collaborations, and individuals had dramatically changed and ultimately improved how the biotechnology industry develops, manufactures, and delivers life-changing medications to a global population.

From that consideration, we decided to create an inaugural *BioProcess International* Award Program to recognize and celebrate those outstanding technologies, technical applications, collaborations, and thought leaders that, over this past decade, have had the greatest positive impact on each of the "three pillars" of bioprocessing: Upstream Processing, Downstream Processing, and Manufacturing.

In January 2012, *BioProcess International* introduced the 2012 Awards program and opened nominations to the industry through a secure online site. Nominations remained open through 30 June 2012. Each submitted nomination was transferred to an individual ballot form. We consolidated those ballots by pillar and electronically sent them in batches to judges we had selected based upon their unique expertise. They received ballots containing only an entry number and an ID number unique to each submission. Each judge scored the separate narratives (answers to four or five questions, depending on the category) in a ballot on a scale from 1 (low) to 5 (high) and sent it directly to *Deloitte & Touche LLC*. The auditors worked with us at every step to ensure that the ballots arrived in proper format. The firm then certified and compiled those scores and sent BPI lists of the top three scorers for each category within the three pillars. To confirm impartiality, each judge submitted a signed statement that he or she had scored the nominations fairly and impartially according to the set guidelines.

Now, *BioProcess International* is proud to formally introduce the 36 *BioProcess International* Award finalists for 2012. This exclusive group represents the very best technologies, applications, collaborations, and thought leaders that the bioprocessing industry has to offer.

On 9 October 2012, *BioProcess International* will host a special reception and ceremony to honor all those finalists and recognize the 12 award winners. We hope you will join us at the awards ceremony taking place at our annual conference in Providence RI, 8-12 October 2012, as we begin the journey together into the future of our industry.

Brian J. Caine
Publisher

S. Anne Montgomery
Editor in Chief

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The Upstream Processing Pillar

The Upstream Processing pillar recognizes technologies, partnerships, and innovative thinking that contributed to dramatically improved production titers and reduced overall costs and capacity requirements. Over the past 10 years we have seen the biopharmaceutical industry transformed by these innovations. Vaccines have experienced a renaissance thanks to recombinant technologies, and cell and gene therapies are now poised to enter the market — if their developers can learn from the experiences of those who have come before. Sophisticated approaches to process design enable process modeling, and quality-by-design initiatives promote new ways of looking at process design and validation. Meanwhile, single-use technology is changing the look, feel, size, and functionality of bioprocess facilities around the world.

The finalists in this pillar reflect many of the trends identified here, highlighting single-use technologies, perfusion culture, cell-line genomics, vaccine production for pandemic preparation, and engineering approaches to upstream process development.

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ATMI LifeSciences provides the Integrity™ line of single-use bioprocessing and fluid-handling solutions to the biopharmaceutical, vaccine and cellular therapy industries. ATMI provides worldwide supply chain security, integratable single-use technologies, integratable units of operation and ongoing innovation to increase process efficiencies for the lifesciences industry.

Technology of the Decade — The Finalists

The Technology of the Decade Award recognizes game-changing innovations in equipment, raw materials and/or tools that significantly transformed drug development and manufacturing, improving process efficiency and accelerating market entry.

Technology: The WAVE Bioreactor: An Early Disruptive Technology

Company: **GE Healthcare**

GE Healthcare

imagination at work

The WAVE Bioreactor was the world's first truly single-use bioreactor. With its introduction in the mid 1990s, the landscape of cell culture from lab to production scale began to change dramatically. It was the first GMP-ready technology for single-use manufacturing. By the time BPI published its first single-use supplement in 2004, this bioreactor had already paved the way for a prolonged revolution in the industry's approach to manufacturing. Today, single-use bioreactors are the default choice for seed train and clinical manufacturing operations. The proliferation of single-use technology continues to be aided by the wide success of this pioneering design.

Technology: ATF (Alternating Tangential Flow) System

Company: **Refine Technology**

Refine TECHNOLOGY

The ATF System is based upon the technology of alternating tangential flow, generated by a diaphragm moving upward and then downward within a pump head, connected to a filter housing, and usually attached to a standard bioreactor. Its ability to generate high flows with low shear offers many benefits for cell culture, including cleaning of the filter surface and supporting growth to high cell concentrations in a number of cell lines. A key business deliverable is repeatable delivery of high cell concentrations in all bioreactors, including at scale. Cost savings are chiefly from reductions in numbers/sizes of bioreactors needed.

Technology: The First Single-Use, Stirred-Tank Cell Culture Bioreactor (SUB)

Company: **Thermo Scientific**

Thermo SCIENTIFIC

The first commercially available stirred-tank cell culture bioreactor was launched in early 2006 by HyClone (now Thermo Scientific). At the time of its introduction, other disposable bioreactor technologies were limited to smaller-scale production. The SUB scalability and range of sizes met the needs of traditional mixing, from 25 liters to 2,000 liters. The true innovation is the sophisticated single-use "bag" part of the system, wherein all traditional bioreactor functions are incorporated but with single-use surfaces, including sparging, agitation, sampling, monitoring, harvesting, and supplementing. The SUB further revolutionized acceptance of disposables in upstream processing, driving penetration of single-use products into the cell culture market.

The Technical Application of the Decade Award recognizes user companies' successful adoption and implementation of game-changing processes and best practices resulting in improved approaches to process design, development, and manufacturing.

Technical Application of the Decade — The Finalists

Technology: Optimizing Cell Retention Using Perfusion Cultivation

Company: Bayer HealthCare Cell Culture Development Group (US) and Bayer Technology Services (Germany)

Perfusion cultivation of mammalian cells can be used with complex and unstable biotherapeutics such as rFVIII that cannot be manufactured using a traditional fed-batch approach. Full-length rFVIII is the largest and most complex biopharmaceutical in the market today, with 20 N-linked and at least 7 O-linked glycosylation sites. In addition, rFVIII is highly unstable: Exposure to cell culture temperatures of 37 °C results in ~50% reduction in activity in less than 24 hours. The perfusion process honored here was designed at Bayer to produce this highly complex and unstable molecule with the correct glycosylation profile.

Technology: Implementation of Scalable, Disposable 10-mL Bioreactors into R&D

Company: GlaxoSmithKline and Pfenex, Inc.

Microbioreactor technologies (using the disposable Micro-24/Cellerator by Microreactor Technologies, now Pall Corporation) and applications were developed for microbial and mammalian expression systems. Implementation of scalable, disposable 10-mL bioreactors into R&D was unknown before Tiffany Rau and Torben Bruck innovated and redefined the next generation of strain/clone selection and process development. The system and applications are used to screen cell lines and conduct process development and DoE experiments to improve selection of the "right" strain/clone and process. This work also celebrates how microbial and mammalian worlds came together to deliver the next generation of tools and processes.

Technology: Single-Use Technology for Production of Bacterial Proteins

Company: Therapeutic Proteins International, LLC

Sarfaraz Niazi developed and implemented a unique single-use technology for upstream production of bacterial proteins in a flexible bags. The design incorporates significant modification of the flexible pillow bags popularized by the WAVE technology to allow instant oxygenation and large exhausts. They are kept stationary to reduce stress on bag seams. It enables the company to perform upstream and downstream operations in the same flexible bioreactor for large-scale GMP production of bacterial and mammalian cell proteins. This technology saves millions of dollars of capital cost and substantial process cost of manufacturing and assures the highest degree of regulatory compliance.

Collaboration of the Decade — The Finalists

The Collaboration of the Decade Award recognizes industry alliances and collaborations whose innovative partnerships dramatically transformed stand-alone technologies. These collaborations resulted in overall process cost reduction while creating new, effective approaches to biopharmaceutical design, development, and manufacturing.

Project: Worldwide Supply and Distribution Agreements to Develop Novel Filtration Systems

Company: **Refine Technology, GE Healthcare, and Sartorius Stedim Biotech**

Refine Technology's objective is to dramatically reduce the risk and cost of upstream processing through continuous culture and process intensification. To that end, the company signed a worldwide supply and distribution agreement with GE Healthcare, which supplies hollow-fiber filtration cartridges for use with Refine's ATF system for perfusion cell culture. Additionally, Sartorius Stedim Biotech and Refine Technology collaborated toward developing a robust platform for high-density perfusion cell cultivation, enabling fast and easy connection of the ATF System to SSB's single-use BIOSTAT® bioreactors. SSB and Refine provided users with initial application and protocol guidance for these connections.

Project: Genomic Sequencing of the Chinese Hamster Genome Database

Company: **CHO Genome User Group, www.chogenome.org**

This large collaboration of companies and researchers produced the draft genomic sequence of the CHO-K1 ancestral cell line: 2.45 Gb of genomic sequence with 24,383 predicted genes. CHO-derived immortalized cell lines are the preferred host system for therapeutic protein production, but previous progress was made without availability of genomic sequences. The annotated public genome sequence for a CHO cell line represents another tool in the bioprocessing toolbox, providing genome-scale science for optimizing biopharmaceutical protein production. It facilitates targeted genetic manipulations, helps elucidate poorly characterized phenotypes, and allows for comprehensive deployment of "-omic" tools for CHO-K1 and related cell lines.

Project: Xcellerex AMP Program Team (DARPA – AMP)

Company: **Xcellerex Inc., Pfenex, Inc., deltaDOT, Ltd., Biopharm Services, Inc., and the Latham BioPharm Group**

In 2007, the US Defense Advanced Research Projects Agency (DARPA) launched an ambitious program, Accelerated Manufacture of Pharmaceuticals (AMP), aimed at developing ultrafast biomanufacturing technologies. The Xcellerex AMP collaboration resulted in a high-efficiency bacterial expression system to produce a model vaccine and antibody. The *Pf*enex expression technology is based on *Pseudomonas fluorescens*, which expresses recombinant proteins at high titers. The system has developed a strong track record in producing a number of different types of complex molecules including vaccines, virus-like particles, engineered proteins such as scaffolds, and antibody derivatives in addition to fully assembled MAbs.

The Thought Leader of the Decade Award recognizes an industry visionary whose work, accomplishments, and reputation are remembered as being a catalyst for change; who is universally regarded as an instrument of change and instruction; and who developed, championed, and implemented best practices, while encouraging humanitarian/ philanthropic efforts.

Thought Leader of the Decade — The Finalists

Name: **Parrish Galliher**

Technologist and Entrepreneur

There are technologists who come up with great ideas and entrepreneurs who found companies to develop technologies. Parrish is a rare individual who does both. He made significant personal and professional sacrifices to forward his vision of a truly modular disposable facility, one powered by a large-scale single-use bioreactor. He took on substantial risk to found Xcellerex based on his unwavering belief in this manufacturing approach. In promoting the industry's move to single-use reactors, he has helped companies save significant time and money in development and manufacturing of important biologics. Xcellerex's recent purchase by GE should further enhance this "revolution."

Name: **Chetan T. Goudar**

A Champion of Systems Biology

Goudar worked at Bayer HealthCare over the past decade, responsible for developing robust cell culture processes for new biologics and producing material for preclinical and phase 1–3 clinical trials. Since 2002 he championed adaptation of a systems biology approach toward cell culture development. This started with work on quasi-real-time metabolic flux analysis in 2002, followed by work on 13C-glucose flux analysis using 2D-NMR, gene expression profiling using cross-species hybridization, application of metabolomics to industrial-scale mammalian cultures, and recently, the completion of the effort to sequence the baby hamster kidney (BHK) genome. He joined Amgen as Director, Cell Sciences and Technology in May 2012.

Name: **Jerold Martin**

Industry Spokesperson and Single-Use Champion

Jerry has been a stalwart, consistent, loyal spokesperson for the biopharma industry since before many of the current experts in the field were born. His knowledge transcends partisanship. He volunteers his time, energy, and resources to committees, conversations, and industry dialogs. He doesn't judge people based on what they can do for him, but rather on their commitment, honesty, and the merits of their contributions to the industry and society. As one of the founders of the Bio Process Systems Alliance (BPSA), he has been a major champion for the adoption of, and guideline development for single-use technologies.

2012 BioProcess International Awards

UPSTREAM

The Downstream Processing Pillar

The Downstream Processing pillar recognizes technologies, partnerships, and innovative thinking that help the bioprocessing industry recognize, address, and overcome what many have labeled as the looming "downstream bottleneck." When BPI's first decade began, a fairly mature industry was working through a crisis in manufacturing capacity, and dire predictions of an industry-wide downstream bottleneck soon occupied the pages of many trade publications. With increasing product titers coming from upstream production, existing downstream processes struggled to keep up. Under the pressures of time, competition, and dwindling resources in a stressed global economy, people working downstream are using quality by design and devoting attention to reducing their own process footprints, extending single-use, modularity, and other new technologies to increase flexibility and seeking to reduce the number of purification steps required.

The finalists in this pillar reflect many of the trends identified here, with analytical instrumentation; inline buffer dilution; computational fluid dynamics; filtration advancements, virus filters, and high-capacity capture methods; new ligands and protein A improvements for affinity chromatography, and multimodal chromatography. Thought leaders stand at the forefront of quality-by-design implementation as well as operational excellence and development of single-use technologies.

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GE Healthcare Life Sciences provides products and expertise for developers and manufacturers of biotherapeutics to enable efficient, flexible and cost-effective approaches to characterization, expression, and purification of biomolecules. The company offers tools and support to take recombinant proteins, monoclonal antibodies, plasma proteins, oligonucleotides, and vaccines from research, through process development, to full-scale manufacturing.

The Technology of the Decade Award recognizes game-changing innovations in equipment, raw materials and/or tools that significantly transformed drug development and manufacturing, improving process efficiency and accelerating market entry.

Technology of the Decade — The Finalists

Technology: The PLEX-ID System for Rapid Microbial Detection

Company: Abbott Laboratories–Ibis Biosciences

Initiatives such as QbD and PAT call for better control of manufacturing process to ensure final quality. Originally designed for biothreat and public-health applications, the PLEX-ID system offers rapid, broad detection and identification of known and emerging organisms from multilocus base composition analysis. The genotypic system uses PCR amplification followed by MS detection to identify viruses, bacteria, or fungi within eight hours, direct from sample to results. The PLEX-ID system enables manufacturers to better control their process from cell banks to final products, guarding against virus contamination and ensuring rapid identification of excursions of adventitious agents.

Technology: IBD™ Inline Buffer Dilution Systems

Company: Asahi Kasei Bioprocess

Increased protein titers from upstream processes require substantial quantities of diluted buffers for downstream processing. Introduced in 2007, IBD systems help manufacturers prepare 1× binary and ternary buffer blends from ≤20× salt-solution concentrates for purification. Process analytical technology controls pH and conductivity simultaneously, and large buffer tanks are replaced with disposable bags. The systems minimize batch variation and reduce the need to discard/reprocess buffers that fail required specifications. Direct cost savings come from reduced capital expenses for large-volume buffer hold tanks, reduced operating costs (offline buffer QC, tank cleaning, and cleaning validation), and improved turnaround times.

Technology: Planova™ Virus-Removal Filters

Company: Asahi Kasei Bioprocess

Planova virus-removal filters eliminate viruses from mammalian cell lines or human plasma during biotherapeutic production. Building on the success of the world's first virus-removal filter (Planova 35N, introduced in 1989), the family expanded in this past decade to include Planova 15N (the world's first parvovirus removal filter) and Planova 20N, with respective mean pore sizes of 15 nm and 20 nm. By combining robust performance with unique scalability, this family of filters accommodates development through commercial projects. The filters combine reliable, high-throughput filtration with maximum product recovery and virus retention, removing endogenous and adventitious viruses without compromising product viability.

Technical Application of the Decade — The Finalists

The Technical Application of the Decade Award recognizes user companies' successful adoption and implementation of game-changing processes and best practices resulting in improved approaches to process design, development, and manufacturing.

Technology: Computational Fluid Dynamics (CFD)

Company: **Amgen**

Amgen researchers used CFD to gain a fundamental understanding of fluid and mass transfer inside a large-scale packed chromatography column. Their work fulfilled a need for insight into fluid flow and related phenomena to mitigate risks associated with process equipment scale-up. They showed how CFD and other traditional techniques can be used to complement each other. The application enhances understanding of flow distribution and aids in fabrication/testing of large-scale chromatography columns. It facilitates new design features for reducing the risk of microbial contamination. Similar approaches to other downstream and upstream unit operations can help companies gain valuable process understanding.

Technology: Optimization and Scale-Up of Ultrafiltration/Diafiltration in Clinical Manufacturing

Company: **Human Genome Sciences**

Large amounts of a MAb drug are often required for sufficient therapeutic effect, but delivery is limited by subcutaneous injection volume. This experimental approach (published in 2008) focuses on optimization and scale-up of the ultrafiltration/diafiltration step in clinical manufacturing of a MAb formulation. The robust, scalable formulation step enabled production of clinical supplies at concentrations ≤183 mg/mL of protein. The team used Millipore's Pellicon 2 tangential flow mini-cassette with Biomax polyethersulfone 50 kDa membrane and C screen to examine the UF/DF process for ABthrax protein, a MAb in clinical development for neutralization of anthrax toxin.

Technology: Development of a High Capacity MAb Capture Step to Replace Protein A

Company: **Percivia, LLC**

Blanca Lain et al. concluded that Toyopearl GigaCap S-650M media can capture a monoclonal IgG1 with ≥90 g/L dynamic binding capacity. Their goal was to develop a high-capacity MAb capture step to replace protein A affinity chromatography. This approach can be used with other methods for commercial production of antibodies, addressing the challenge of improving downstream throughput of higher-titer MAb feedstocks — while reducing process costs. The high-capacity step using CEX chromatography captured MAbs from clarified harvests with a binding capacity of ≥90 g/L, ≥95% product recovery, and purity comparable to that achievable with protein A, including ≥95% HCP reduction.

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Collaboration of the Decade — The Finalists

Project: New Affinity-Ligand–Based Chromatographic Media

Company: GE Healthcare and BAC BV

Since 2006, GE Healthcare and BAC have had an ongoing, successful collaboration to develop technologies for improving manufacturing efficiency. This has led to the commercial launch of seven products that are used in biomanufacturing worldwide. The work stemmed from BAC's development of unique affinity ligands based upon camelid-derived single-domain antibody fragments. The collaboration brought this technology from research scale to the wider bioprocess community by delivering high-quality media based upon those antibodies. These results show how open innovation can bring high-quality and fit-for-purpose products to the market in a short time frame.

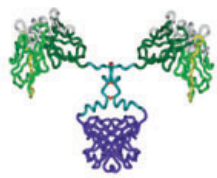
Project: Creation of a GMP-Compliant, Reproducible, Robust Crystallization Method

Company: University of Applied Sciences Biberach, Boehringer Ingelheim, Rentschler Biotechnologie GmbH, and the Karlsruhe Institute of Technology (KIT)

In 2007, the BMBF (Bundesministerium für Bildung und Forschung) launched an initiative to fund development of new purification techniques in Germany. The interdisciplinary consortium honored here is coordinated by the faculty for pharmaceutical biotechnology at the University of Biberach. They seek to create a GMP-compliant, reproducible, robust crystallization method for producing pure crystals in complex protein mixtures. Through this work, biologists, biochemists, chemists, and process engineers hope to learn how technical protein crystallization can be applied as a novel separation process for biopharmaceuticals, and antibodies in particular. Researchers suggest that it may become an acceptable alternative to affinity chromatography.

Project: Genetically Engineered Immunological Constructs

Company: Validated Biosystems, City of Hope Medical Center's Beckman Research Institute, and the Crump Institute for Molecular Imaging's Department of Molecular and Medical Pharmacology at UCLA's David Geffen School of Medicine



Small, genetically engineered immunological constructs (minibodies) are being developed for a growing range of in vivo applications. Their small size potentially gives them access to tissues that are poorly accessible by intact antibodies; rapid clearance from blood and nontargeted tissues; lower immunogenic response; and eye-drop, inhalant, and oral administration routes. This 2010 work describes new approaches to key challenges with early phase minibody purification process development. Using mixed modes in process chromatography has solved purification problems that traditional methods could not. A number of presentations and publications now suggest that process developers include mixed modes at early development stages.

Thought Leader of the Decade — The Finalists

The Thought Leader of the Decade Award recognizes an industry visionary whose work, accomplishments, and reputation are remembered as being a catalyst for change; who is universally regarded as an instrument of change and instruction; and who developed, championed, and implemented best practices, while encouraging humanitarian/philanthropic efforts.

Name: **Günter Jagschies**

A Visionary Leader in Pursuit of Industrial Excellence

Jagschies challenges the status quo in the industry through thought-provoking analyses of the state of manufacturing, industry trends, and corporate strategies. Employed by one of the industry's largest suppliers, he objectively pursues industrial excellence in biotechnology. His greatest skill is an ability to anticipate trends (e.g., the downstream bottleneck and advantages of single-use technologies) and stimulate discussion long before issues become problems. In open forums, he encourages others to rethink the status quo — to analyze problems as a system, rather than as a sum of individual parts, putting commercial interests aside for the greater good of the industry.

Name: **Duncan Low**

Downstream Processing Pioneer

Low has been a pioneer of downstream processes. He leads cross-functional teams for materials and technology evaluation, technology development, and process analytical technology. He serves on the ISPE Executive Committee for PAT and USP's Committee of Experts, and he chairs the ASTM E55.01 subcommittee to develop consensus standards for biomanufacturing. He has extensive experience with upstream and downstream processing tools and works closely with applications development. Over the past decade, he has shed light on the protein A purification step (among others), facilitating more efficient use of that technology and seeking ways to improve yields

Name: **Jerold Martin**

Driving Best Practices for Single-Use Adoption

Martin has been at the forefront of the introduction of integrated, validated, complete biomanufacturing systems, skillfully helping to translate needs and capabilities into ideas and products. He was a driving force behind adoption of large-scale filter capsules and advancements in tubing, sterile connectors, membrane chromatography, and process containers. Over the past decade, he has been a major proponent of single-use equipment especially, and his best-practice guides are widely adopted. He contributes regularly to educational, trade, and scientific efforts to promote disposables. He is a scientific visionary who has had an ongoing, significant, and positive influence on the biopharmaceutical industry.

Manufacturing Pillar

The Manufacturing pillar recognizes technologies, partnerships, and innovative thinking that have redefined how and where biotech companies can effectively and profitably produce and distribute products at commercial-scale volumes. Ten years of *BioProcess International* have followed the increased globalization of the biotechnology industry. Harmonized regulations continue to address ways in which companies can enter multiple markets. Quality by design is enabling efficient and cost-effective optimization of existing processes. Sponsors now have broader choices to make regarding where their products will be manufactured and marketed, and biotechnology hubs are becoming established around the globe. Regions of the Asia–Pacific are developing infrastructure to support work toward producing lower-cost drugs and vaccines to their own populations. And debate over the future of biosimilars/biobetters continues, as regulatory pathways continue to be mapped.

The finalists in this pillar reflect the trends described here with new protein formulation concepts, fluid-management solutions and other single-use technologies, product characterization and information management, new product classes, automation applications, and novel partnerships and industry support. Thought leaders are experts in single-use technology, cost management, aseptic processing, contamination control, and risk management.

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Technology of the Decade — The Finalists

The Technology of the Decade Award recognizes game-changing innovations in equipment, raw materials and/or tools that significantly transformed drug development and manufacturing, improving process efficiency and accelerating market entry.

Technology: Crystalomics Technology — Delivering Highly Concentrated Biologics

Company: **Althea Technologies**

Crystalomics technology produces highly concentrated crystallized therapeutic proteins in suspension, creating products with patient-friendly dosage and delivery formats. Crystallized proteins can be formulated for conversion of low-concentration intravenous infusions to subcutaneous injections. Such formulations have low viscosity, allowing use of 29-gauge or narrower needles, which limits patient discomfort and facilitates self-administration. Additional technology increases the serum half-life of short-lived proteins, decreasing their dosing frequencies while increasing patient convenience and compliance. So far, crystalomics technology has proven to be appropriate for oral, pulmonary, and topical delivery and SC injection of >100 different proteins, including antibodies, hormones, enzymes, and peptides.

Technology: Steam-Thru Connections — Pioneering Technology for Hybrid Systems

Company: **Colder Products Company**

Steam-Thru connections represent the first technology to create sterile connections of stainless-steel processing equipment with single-use bag and tube assemblies. A three-port design allows for a steam-through SIP process, eliminating "dead legs" and use of a laminar flow hood. Quick sterile connections save time and money by minimizing the risk of cross contamination and reducing labor hours. Applications include harvest bags in fermentation processes and disposable transfer lines for fill-and-finish applications. In final filling operations, these connections replace traditional product transfer through stainless piping, eliminating the need for cleaning validation. They are used in upstream and downstream processes worldwide.

Technology: Innovative Development of Single-Use Applications

Company: **Sartorius Stedim Biotech**

Sartorius Stedim Biotech is an innovator of single-use manufacturing technologies for bioprocess applications. Over the past decade, Sartorius and Stedim identified needs for next-generation bioprocesses, developing single-use technologies and products for upstream and downstream applications. They merged and defined new ways to integrate standardized production units, developing single-use bags, mixing stations, storage pallet tanks, filter capsule technology, virus filters, and crossflow filtration units. SSB FlexAct operation units for process control benefit from SU sensor technology and monitoring. High flexibility, speed to market, and an ability to support complete processes strengthen the combined company's overall industry impact.

The Technical Application of the Decade Award recognizes user companies' successful adoption and implementation of game-changing processes and best practices resulting in improved approaches to process design, development, and manufacturing.

Technical Application of the Decade — The Finalists

Technology: Data Collection and Analysis During Preformulation of Biotherapeutic Proteins

Company: **Genzyme Corporation**

"Singular-value decomposition" (SVD) analysis is a mathematical method that fits a large dataset quickly to reveal the number of distinct spectroscopic species present during protein unfolding. SVD breaks down data into a minimum number of independent basis vectors, each with its own spectrum and temperature dependence. Time constraints and limited sample amounts available for preformulation research limit the choices of available experiments, so maximizing the use of data collected is crucial to robust assessments of a molecule's solution behavior. This work illustrates the potentially broad use of thermodynamic analysis and transition plot construction in biotherapeutic development.

Technology: Automated, Closed Single-Use Bioreactor for Cell Therapy Development

Company: **ReGenesys**

The Quantum Cell Expansion System, manufactured by TerumoBCT, streamlines cell culture processes, reducing contamination risk in clinical cell manufacturing. It brings automation, a closed environment, and process reproducibility to research, clinical trials, and commercial cell therapy development. The disposable bioreactor comprises thousands of hollow fibers, providing a large but compact surface area for cell attachment. Media and waste components pass through porous membranes while a gas transfer module regulates gas concentration. ReGenesys applied this technology to GMP production of MultiStem cells for initial clinical trials. The company anticipates easy scale-up using multiple machines to deliver consistently high-quality products.

Technology: Clinical Trial Solutions for Filling Drug-Delivery Systems

Company: **Vetter Pharma International GmbH**

Supporting early development of parenteral drugs, the Vetter Development Service (VDS) site in Chicago, IL, relies on a Bosch MHI 2020B vial filler: the first of its kind specifically designed for clinical manufacturing. It enables automated vial filling and closing, particularly for small drug volumes. Using disposable systems and a restricted access barrier system (RABS) reduces the risk of contamination, protecting product safety and integrity. The apparatus is connected to a freeze-dryer and used for filling either lyophilized or liquid products. Incorporation of this machine enables fast, efficient, and safe filling of active drug substances for clinical studies.

Collaboration of the Decade — The Finalists

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Project: Trusted Partner Network (TPN) — A Capacity-Sharing Strategy

Company: Merck and MedImmune, LLC

Merck and MedImmune signed a 15-year collaboration on 15 September 2011. Their trusted partner network (TPN) illustrates a way for one company to offset pipeline disappointment and another to avoid a huge capital investment. The deal centers on MedImmune's Frederick, MD plant but opens up Merck's microbial capacity to MedImmune, benefitting both parties. MedImmune gets the advantage of an operating facility but avoids the write-down of stranded capacity; it protects its own pipeline while enabling Merck to invest in capital expansion even several years out. Additionally, Merck's access to the facility provides a significant time-to-market advantage.

Project: NIBRT (National Institute for Bioprocessing Research and Training)

Company: Irish Government, Industry, and Academia

The Irish NIBRT provides manufacturing research and training solutions to address key manufacturing challenges. This collaboration of government, industry, and academia drives process efficiencies, innovation, and compliance across all aspects of biopharmaceutical manufacturing. Projects have included optimizing an existing *Escherichia coli* process for interferon manufacture, enhancing glycan analytical capabilities, implementing advanced spectroscopic techniques, designing and implementing bespoke operations training programs, and rapidly and successfully starting up a new fill–finish vaccine facility. The facility enables its industrial clients to share the load of plant start-up, personnel training, and R&D, and it has given Ireland a competitive market advantage.

Project: PDA: An Important Interface between Industry and Regulators

Company: PDA and Its Members

Since 1946, PDA (the Parenteral Drug Association) has facilitated communication and collaborations among industry and regulators — especially providing comments on draft guidances. With >9,500 members worldwide, this nonprofit association is the main source of technical documents and training materials for the biopharmaceutical industry and regulatory authorities. Its pragmatic documents create open forums for essential interactions among all groups working to design and develop these parenteral drugs. PDA is committed to developing scientifically sound, practical technical information and resources to advance science and regulation. Its work is based on understanding that adopting new technologies requires creating scientific interaction platforms with regulators.

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Thought Leader of the Decade — The Finalists

Name: **Jim Akers**

Building a Foundation of Aseptic Processing

Akers has been a true industry thought leader over the past 30 years. His early work in developing new techniques for aseptic processing laid the technical foundation for the industry to implement new technologies. These techniques are now used in most bioprocesses, enhancing process safety and easing the work of end users. His >100 technical and review articles reveal the significant impact of his continuing contributions to the biopharmaceutical industry. They address validation, aseptic processing, contamination control, environmental monitoring and control, isolator, isolator technology, sterilization and disinfection, sterility testing, media fill testing, HACCP analysis, pharmaceutical microbiology, and regulatory compliance.

Name: **Jerold Martin**

Driving a Paradigm Shift in Biomanufacturing

Martin is a senior vice president for global affairs for Pall Life Sciences, with >33 years of experience in microbiology and technical services, R&D, technical marketing, and as an industry/regulatory liaison. He has played a leading role in the implementation of single-use manufacturing in the biopharmaceutical industry, leading the Bio Process Systems Alliance (BPSA) in developing a series of consensus best-practice guides that have become broadly accepted. His promotion of single-use technologies sparked a paradigm shift for the industry, enabling companies to reduce capital costs and increase manufacturing flexibility and helping them compete in the global market.

Name: **Andrew Sinclair**

Developing Product Life Cycle Management Tools

Andrew Sinclair continues to anticipate issues and challenges faced by the biopharmaceutical industry and ways to address them. He has been instrumental in helping the industry deliver affordable biologics by focusing on ways to improve cost effectiveness of manufactured drugs. Over the past 10 years, he worked to communicate the impact of process and technology choices on product cost and manufacturability, developing widely used software tools to enable companies to understand the implications of their process and technology choices. He is now actively promoting the next game-changing topic: process knowledge management for driving efficiency and reducing development and manufacturing costs.

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