BSC Ergonomics

IMPROVING SCIENCE THROUGH COMFORT

BY JEREMY SANDLER

Life science research often requires long hours in the laboratory. Because of the sensitive and biohazardous nature of life science work, a significant portion of time is spent using biological safety cabinets (BSCs). BSCs play a pivotal role in life science research laboratories as they are designed to support cell culturing, microbiology sample preparation, and other laboratory applications that require personnel and product protection.

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To stay comfortable every day while preventing long-term injury, cabinet users need a biosafety cabinet that is designed around the human body. Ergonomic factors that keep a user safe include physical designs that reduce repetitive injury and allow a user to sit comfortably, component selections that ease strain on users, and consideration for key accessories that promote good posture.

Conscious of the need to protect students, scientists, and professors conducting critical research in campus labs, private colleges and universities are re-evaluating the ergonomic design of the BSCs they use.

Understanding the Risks Behind the Glass

There are also intrinsic risks associated with BSC use. Common risks accompanying these jobs include:

- Poor working posture – head bent forward for extended periods, raised and/or outstretched arms, fixed postures held for prolonged periods.
- Upper limb disorder risks – repetitive actions, awkward wrist/arm posture, forceful actions (including pinching grips).
- Environment – space constraints, lighting temperature, vibration, etc.
- Load – working with sharp, hot, cold or toxic/hazardous objects.
- PPE challenges – personnel protective equipment that might make work more taxing.
- Fatigue – an accumulation of multiple risk factors listed above.
- Repetitive strain injuries

Designing a BSC to minimize these risks to the user is a critical component of overall laboratory safety.

BSC Design Standards

High-quality BSCs are designed, tested and listed to an approved performance standard such as the National Sanitation Foundation's NSF/ANSI Standard 49 or the European Union's standard EN 12469. These standards ensure BSCs provide a basic, safe environment for working with biohazards, provided the cabinet is operating properly. BSC design can positively impact productivity and reinforce safety standards when the end user's comfort while operating the equipment is included in design calculations. As the UK's Health and Safety Executive explains, "Designing tasks, equipment, and work stations to suit the user can reduce human error, accidents and ill-health. Failure to observe ergonomic principles can have serious consequences for individuals and for the whole organization. Effective use of ergonomics will make work safer, healthier and more productive"[1].

BSC regulatory standards, while focused on containment of biohazards and safe operation, have limited requirements for human factors and user comfort specifications. Driven by competition, manufacturers have made great advances by engineering products to increase safety through improved comfort. These design features must be evaluated by researchers, technicians and

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safety officers. It is important for users to completely evaluate a product for all safety, ergonomic and comfort features, as there are vast differences between how each manufacturer approaches BSC design and ergonomic engineering.

The development of BSCs includes elements influenced by historical requirements and others designed through engineering innovation. Labconco, a leading leader in designing laboratory equipment, and studied existing BSCs on the market saw a need for updated ergonomic features. This led to the development of the new Logic® BSC, which integrates effective and comprehensive ergonomic features, like Inclination™ Technology and the Logic™ Operating System.

Labconco's approach to ergonomic design has evolved significantly over time. Early Class II Biosafety Cabinets resembled fume hoods, featuring console units with 90° vertical safety glass sashes that did not fully close when not in use. These units had ergonomic limitations, as microbiological tasks often involve long, repetitive procedures. Standing at these cabinets created physical strain on operators' backs, legs, arms, and necks.

The First Purifier

Prior to the 1980s, most biosafety cabinets resembled fume hoods and required operators to stand while working. For tasks requiring precision and long periods of focus, this setup posed significant ergonomic challenges. Prolonged standing can increase lower back strain and reduce overall operator endurance.

In 1983, Labconco introduced its first bench-mounted Purifier Series Class II BSC, designed for seated use. Seated operation not only improves posture and comfort but also enhances accuracy in repetitive or delicate procedures such as aseptic techniques or cell culturing. The reconfiguration of internal systems allowed the cabinet to be bench-mounted, and the sash was angled 10° inward from vertical, enabling users to sit closer to the work zone comfortably with improved posture, reduced fatigue, and decreased glare from reflections. This ergonomic redesign addressed users' immediate comfort needs and was quickly adopted across the industry.

Delta's Enhancements

In the late 1990s, ergonomic awareness in laboratory design began to shift from convenience to necessity. The diverse physical needs of each laboratory personnel (especially in shared-use environments) meant that a one-size-fits-all approach would no longer suffice.

To further enhance design, collaborating with ergonomics specialists and microbiologists, Labconco released of the Purifier Delta® in 2000. This cabinet improved ergonomic standards significantly, accommodating users from the 2.5 to 97.5 percentile for height with the first adjustable-height telescoping base stand and hydraulic base stands for adjustments while the BSC is already mounted.

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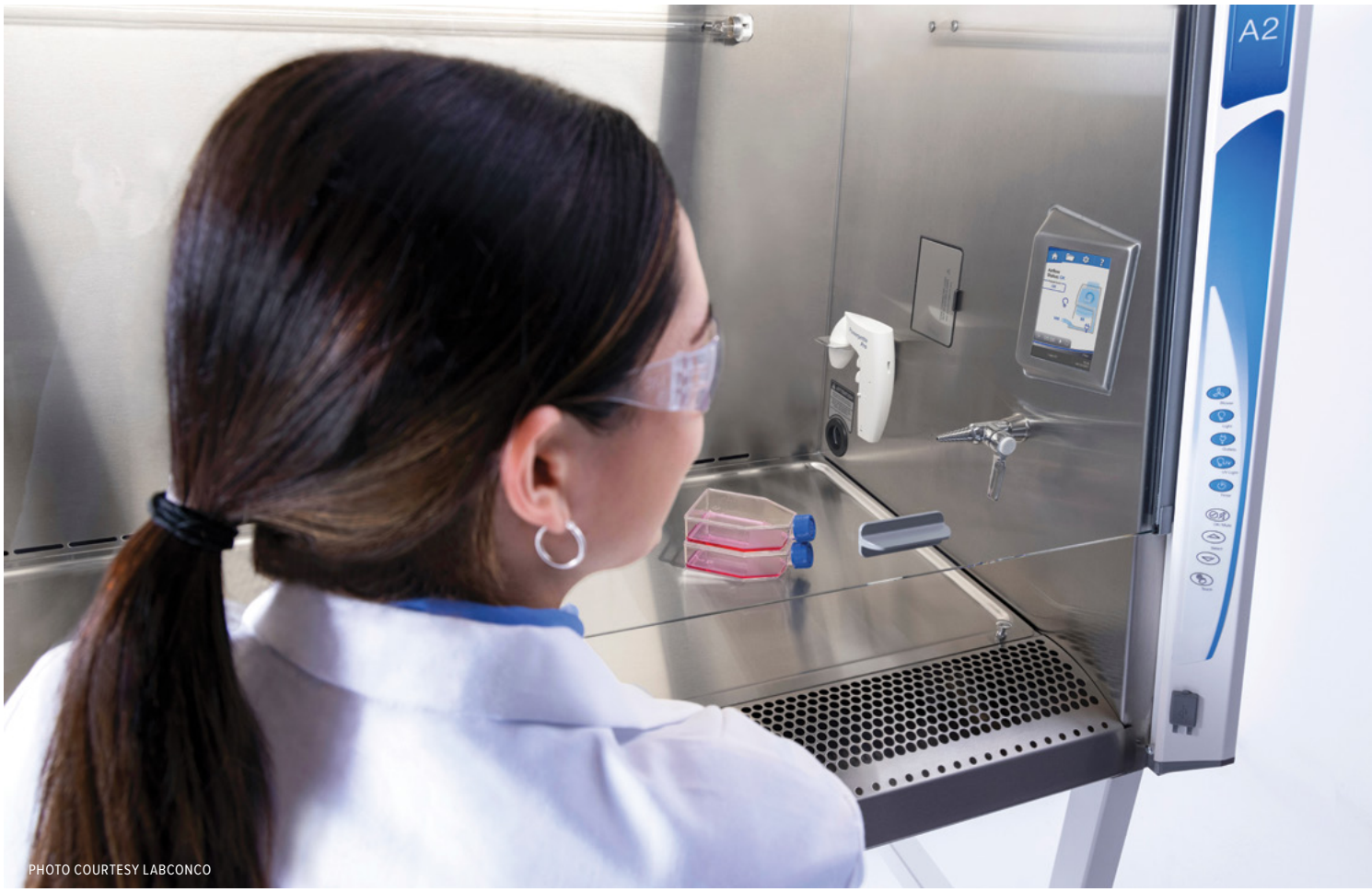

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This new cabinet introduced two sash height options (8" and 10") to better match a user's eye level, arm reach and posture. Prior to 2000, the use of ultraviolet (UV) lights to disinfect BSCs was limited by cabinets' inability to fully close the sash. The redesigned sash was fully closable, counterbalanced for smooth movement and operable with just one finger along its entire width. This minimized effort and strain, along with improving visibility. The air inlet grille was elevated and curved, creating a built-in elbow and forearm rest. An added row of airflow slots ensured safety even when arms were resting. The BSC cabinet depth was optimized for comfortable reach to the back wall without causing a cramped feeling, even during extended work sessions. The removable, single piece stamped stainless steel work surface was seamless, easy to clean, and uniquely designed.

Controls were moved from overhead panels to the cabinet's lower right-hand corner, allowing users (seated or standing) to access them without reaching. The analog pressure gauge, previously above eye level, was moved inside for easy viewing while seated. Utility valves and electrical outlets shifted forward and upward on side walls for accessibility without interfering with work.

These thoughtful adjustments made controls ADA-compliant and wheelchair-accessible—an important milestone in inclusive design for laboratory environments.

Logical Comfort

As ergonomic expectations evolved, so did the need for intuitive, technology-driven user interfaces. To further enhance safety and comfort, Labconco incorporated an Electronically Commutated Motor (ECM) blower into the Logic® Biosafety Cabinet, offering superior efficiency and monitoring capabilities compared to traditional motors. Traditional motors generate excess heat and noise due to magnetic field induction, causing discomfort. ECM technology eliminates heat buildup, stabilizing ambient temperature and significantly reducing operational noise by about 50%, creating a quieter working environment that supports long, focused sessions.

Labconco replaced analog gauges with a digital LCD display, mounted for seated visibility. Clear icons and descriptive text provide essential working parameters such as filter load and airflow status, allowing users to quickly assess cabinet status instead of reading an analog gauge. Integrated with the ECM, the LCD display provided real time monitoring of blower performance and status icons. Clear text messages replaced ambiguous indicators like red lights and buzzers, providing specific system condition feedback.

Microbiologists Labconco consulted with also emphasized the need for clearer communication around HEPA filter status. The HEPA Filter Life Remaining Gauge (expressed as a percentage) delivered an accurate, real-time evaluation of filter life – only made possible by

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the incorporation of the ECM. This precision feedback was only possible with the integration of the advanced feedback features of the ECM integrated into the Logic OS operating system.

Biosafety Redefined: Designing for the User of Today – and Tomorrow

Between 2024 and 2025, Labconco redesigned the Logic BSC with the most comprehensive overhaul since the introduction of the Purifier Delta. Every element of the new design was reexamined to focus on improving user experience and ergonomics.

The newly enlarged airflow slots in the curved armrest and redesigned plenum enable more efficient airflow distribution through HEPA filters, achieving an average 35% reduction in sound pressure. The more efficient airflow also allowed the cabinet to run with 30% less energy than before, further reducing heat output. For the user, this translates to a quieter workspace, helping to reduce fatigue and distraction during long periods of seated work. The standard prop-rod underneath the work surface makes interior cleaning a one-person job. No lifting, no awkward holds but instead easy access that reduces strain on the back and shoulders. This also demonstrates that ergonomics and efficiency can work hand-in-hand to save money at the same time as improving operator experience.

User interaction was also reimagined. The 5" touchscreen LCD display is now larger, brighter, and positioned for easy visibility while seated. The new intuitive graphical and text display of BSC functions and alerts improves the user interface and further streamlines operations to increase safety. Users can control BSC settings and functions from the touchscreen, reducing strain from repetitive button presses

Ergonomics is Essential, Not Optional

In biosafety cabinet design, user comfort and operational safety are inseparable. It's up to manufacturers to respond with solutions that do more than just meet regulatory requirements—they must meet human needs, whether the setting is a university campus or a private lab.

The ergonomic evolution of biosafety cabinets isn't just about comfort; it's about redefining what safety looks like in modern laboratories. Labconco remains at the forefront of that evolution by solving the problems that matter most to those behind the glass.

[1]HSE, n.d. Health and Safety Executive: Human Factors Design. [Online] Available at: www.hse.gov.uk/humanfactors

ABOUT THE AUTHOR: Jeremy Sandler, PhD, brings over 20 years of research experience in the life sciences to Labconco as the Product Manager for Biosafety and Laminar Flow. His research spans microbial ecology, plant ecology, genetics, genomics, stem cells, and tissue regeneration. Jeremy is passionate about developing the most advanced and comfortable Biosafety equipment for tomorrow's scientists.

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