# A Blueprint for Training Transformation

The CAE Perspective

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# Mobilizing to Transform Training

## The Current & Future Educational Environment

As modern warfare grows increasingly complex, traditional military training models, designed for an earlier era, are failing to produce skilled personnel at the speed and scale required. Outdated, instructor-driven approaches are inefficient, costly, and misaligned with the needs of "Digital Native" recruits. Meanwhile, advances in learning science, immersive simulation, and data analytics present new opportunities to enhance training effectiveness and adaptability. This article examines the transition from legacy training methods to Learning Ecosystems, which integrate competency-based instruction, Extended Reality (XR), and adaptive digital tools to improve skill acquisition and operational readiness. By shifting the focus from rigid, centralized instruction to personalized, data-driven learning, defence organizations can optimize training outcomes while addressing critical recruitment and retention challenges. To remain competitive, modern armed forces must embrace these innovations, leveraging technology and strategic partnerships to create scalable, efficient training solutions that prepare warfighters for the realities of contemporary combat.

The way militaries train their personnel has remained largely unchanged for decades, but the demands of modern warfare and shifting geopolitical realities make it clear that the status quo is no longer viable. As armed forces struggle with recruitment shortages and the increasing complexity of advanced weapons systems, traditional training models – structured around rigid curricula and standardized instruction – are proving inadequate.

Meanwhile, advances in learning science and technology have revolutionized education in other industries, offering tools that could significantly enhance military training efficiency and effectiveness. By leveraging new instructional methodologies, data-driven decision making, and emerging technologies like Extended Reality (XR) and competency-based learning, defence organizations have the opportunity to reshape how they prepare the next generation of warfighters.

### Legacy Training

Military approaches to technical skills training have remained virtually unchanged for over 50 years. Traditional teaching methods and tools are based on industrial production models, and recruits are routinely pushed through an assembly line of knowledge, expected to achieve competence at pre-determined intervals using instructor-focused design and settings. In many ways, students are passive consumers of tightly controlled and centralized information.

While this approach has previously provided satisfactory outcomes, it is no longer capable of meeting current needs, notably expediently delivering sufficient quantities of graduates with the requisite knowledge, skills, and behaviours to fight, win, and survive on a modern battlefield. In the United States, the Air Force, the Navy, and the Army have all reported substantial difficulty in meeting their training production goals, with the United States Air Force currently over 1,000 pilots short of its end strength requirement. Maritime forces around the world are seeing an erosion of readiness due to personnel shortages exacerbated by training issues – the submarine industrial base alone will need to hire and train 100,000 new skilled trade workers in the next 10 years. The Royal Canadian Air Force has acknowledged the daunting task it faces to train aviators and maintainers for their new fleet of 88 F-35 fighters. Germany announced that its armed forces shrunk by an estimated 1,500 troops in 2023, while 5,800 more personnel left than joined the UK's military in the same period. The advanced capabilities of modern 5th- and 6th-generation combat aircraft demand new skills and competencies from their pilots, who will require new and innovative approaches to training. Training aircraft and equipment are aging, the gap between modern capability and legacy trainers is growing, and the time to train is steadily expanding as front-line readiness rates around the world are becoming increasingly urgent. This is not just a pilot issue, although it is arguably the most acute example. The traditional training model is expensive, inflexible, characterized by inefficient use of resources, and does not favour the individual.

These challenges, when combined with the changing dynamics of an increasingly complex and dangerous world, highlight the need to modernize how defence organizations train and qualify tomorrow's warfighters. Today's troops must train as they fight, in a high-end, complex, and contested environment alongside partners and allies.

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## Mobilizing the Future - The Ingredients

Modern Learning is structured around two critical elements: the educational "tools" and how they are applied. Contemporary learning science – our understanding of how humans learn – governs how these are combined to produce graduates with requisite skills and knowledge. Advances in education technology and Instructional Design (ID), cognitive and behavioural science, and neuroscience are helping training designers outline new approaches to technical skills training designed to optimize time, cost, and scarce resources. These elements have already revolutionized training constructs in academia and other industrial applications. The opportunity to integrate them in the defence arena seems obvious.

Military training transformation places added emphasis on comprehensive needs analysis to sharpen and focus the application of available resources. Anecdote and opinion give way to data analytics in producing informed decisions. Chalk boards and PowerPoint slides yield to Extended Reality (XR) and synthetic environments of stunning immersive ability. Students learn deeply, more quickly, and are evaluated consistently to deliver continuous improvement and growth, becoming lifelong learners in the art and science of their craft.

The student is the heart of current and future educational environments – the product of all training programs. Traditional design considers them "raw material" to be shaped and conformed to static standards through a 19th-century assembly line model. Twenty-first century training programs begin with a heightened focus on desired student outcomes, aligning resources and training design around adaptive, student-centric structures.

Today's military recruits differ in important ways from their 20th-century forebears, especially in their approaches to learning and their comfort with distributed, digital technology. Computers, the Internet, social media, video chat, and interactive digital gaming have changed how we communicate, interact, learn, play, shop, and consume information. Today's students are "Digital Natives," accessing and consuming information and conducting relationships via digital technology. Building training programs and systems that align with the needs and expectations of this new generation of learners requires an acknowledgement of their inclinations and innate skills, as well as their limitations and weaknesses.

A growing body of research shows that focusing on the needs of the student as an individual helps ensure success in delivering more students faster, while providing higher-quality learning experiences with better results.

The instructor is an essential ingredient for the success of 21st-century training. Finding and training a qualified, competent instructor force to serve as educators, in sufficient quantity, has become a significant challenge for many military organizations. Tomorrow's military instructors will require new skills, approaches, and roles.

They will have to develop new competencies in mentorship and coaching, with a focus on improving motivation and student confidence in problem-solving and overcoming adversity. They will need a fundamental understanding of applied cognitive and learning science to develop optimized approaches for teaching and to incorporate best practices in adult education.

Remote and collective instruction techniques are being developed to expand teacher effectiveness, while maintaining the level of individual attention required. By focusing on the unique benefits of a human teacher/coach, technology can expand instructor effectiveness and relieve some of the unnecessary burden imposed by increasing throughput requirements without necessitating a corresponding increase in manning.

Technology is helping to create new ways of optimizing the human element of live instruction by relieving trainers of mundane, easily automated tasks, including scheduling, student administration, and eventually automated coaching and evaluation. This will help strengthen instructor satisfaction and improve retention.

Instructors need support for doing what they do best – providing the human connection between subject and student. Advanced training programs must leverage the unique capability that comes with experience, wisdom, and anecdote – the stories that resonate and link the past with the present and future, delivered as only a teacher can.

Migrating away from an "Information-Giver" role toward becoming a facilitator of learning and a trustworthy provider of relevant, accurate resources, the instructor's principal responsibility is to create an empowering learning environment in which students grow and thrive.

## The Framework - A Learning Ecosystem

A truly innovative training solution requires the integration of many distinct elements, including instructional methodology and technology. Together, they create an interoperable system of complementary learning tools designed to enable a powerful network of learning, from individual to collective – a Learning Ecosystem.

A Learning Ecosystem defines the components and relationships of an optimized training continuum to enhance efficacy and outcomes. It integrates learning science, technology, and data science through a secure, modular, interconnected digital architecture to achieve defined organizational goals. It also promotes a culture of continuous learning.

Learning Ecosystems are a foundational roadmap for integrating and applying tools and learning approaches to optimize outcomes – an interoperable system of complementary learning tools designed to create a powerful network of learning for individuals or collectives. They can include micro- and mobile-learning architectures for truly contextualized learning experiences.

A Learning Ecosystem should be transformative, recognizing and overcoming the challenges of 21st-century design while accommodating future challenges. It should be designed with the end-state in mind, solution-forward, leveraging advanced learning science, data analytics, and educational technology. This holistic system-of-systems approach integrates a range of dynamic, independent components toward a common goal. It must be customer-centric, considering the unique needs of all stakeholders and tailoring solutions to meet operational and readiness requirements.

Learning Ecosystems are grounded on four success enablers: they apply learning science; they are technology-enabled; they are data-informed; and they are people-focused. These enablers provide a curated continuum of lifelong learning, with outcomes tailored to individual performance. Serving as an "internet for learning," educational super-networks improve learning efficacy by focusing on tailored learning at the individual level while creating experiences to optimize performance outcomes of collectives. These ecosystems also deliver improved measures and analyses to help optimize learning experiences and drive continuous improvement and workforce development at a rapid pace.

This concept aligns with that of the U.S. Department of Defense Advanced Distributed Learning (ADL) Initiative's Total Learning Architecture (TLA), comprised of a learner-data strategy, providing exchange and enterprise-wide interoperability of learning systems across all phases of learning.

A deliberate, proactively managed approach to training transformation is called for, based on the objectives and requirements of each customer. The first step is to identify the desired outcomes.

For ensured success in integration, a Learning Ecosystem must include a thorough needs analysis, founded upon a thoughtful data strategy and well-considered ID.

A Needs Analysis identifies performance requirements and gaps within a training system, including knowledge, skills, and abilities required to achieve the desired outcomes. It helps direct resources appropriately, improve effectiveness and efficiency, and ensure resources are best apportioned to close performance gaps. It supports the achievement of lasting improvements in learning efficiency, effectiveness, and affordability, and must precede the design of any training program.

A Data Strategy describes a long-term vision for collecting, storing, analyzing, and evaluating a wide variety of data sources to inform fact-based decision making. It supports an evaluation strategy, aimed at creating a robust process to capture, analyze, and act on inputs (or feedback) from key stakeholders to know how students measure up to expectations and to reduce reliance on assumptions or representative sampling. Data is pooled, processed, and analyzed to identify weaknesses or gaps in the training system to effect continuous improvement.

Modern military training systems generate enormous amounts of data and information on individual and program performance. This vast reservoir of information creates substantial physical, cognitive, affective, and observational data "pools" or "lakes." This information can be leveraged to make informed decisions regarding resourcing, scheduling, training and development, and costing for individual and overall program improvements. These data sources can also include assessment of faculty effectiveness in teaching content and supporting student needs and provide data-driven recommendations on effective instruction.

Data analytics involves extracting meaning from raw data sources by transforming, organizing, and modelling diverse information, drawing logical conclusions and identifying patterns. Data analytics allows instructors to identify student (and program) strengths and weaknesses and make informed adjustments to better motivate learners and define areas for improvement. Data analytics help tailor learning structures and content to an individual learner's needs through adaptive, personalized learning environments. Effective evaluation strategies are achieved through a combination of formative and summative evaluations delivered consistently to students throughout their learning journey, for competence at the right level, at the right time, to the right depth of ability and understanding. Learning Ecosystems flourish when informed by rich, diverse sources of valid, credible data drawn from a wide range of sources. With the early establishment of clear data strategies and standards, training ecosystems are built with data interoperability and linkages as a primary design consideration, resulting in a faster and more consistent flow of accurate, relevant, and usable data.

Instructional Design (ID) is the process by which learning products and experiences are designed, developed, and delivered. Using learning and instructional theory to ensure the quality of instruction, ID aims for a learner-centric approach for effective learning.

A future-proof ID approach allows for flexibility and iterative development, prioritizes individual learner's development of Knowledge, Skills, Abilities, and Behaviours (KSABs), acknowledges and integrates with digitized systems and rapidly changing technology, and allows for built-in continuous improvement.

An approach that interweaves learning science, data, and advanced technology moves us toward a learner-centric, competency-based training solution.

To ensure that learning science, technology, and the desired training outcomes are synchronized, the Instructional Designers, engineers, and technology experts, along with domain subject matter experts, must work collaboratively. This ensures individuals and teams achieve the desired training outcomes and related competencies within given resource and time constraints.

Competency-based learning focuses on the development of specific skills or competencies, where learners demonstrate the required knowledge and skills on a topic or task before advancing to the next level. Rather than focusing on grades and defined curriculum schedules, the main emphasis is placed on how competent each student is in the subject – what they know, or what they can do.

Competency-based education models build on a comprehensive understanding of human learning constructs and limitations. Programs are designed to quickly adjust to an individual learner's needs, improve the speed with which they progress through a given course, task or segment, and increase the knowledge and retention levels for the content. The cumulative result is an increased capacity for greater student throughput and an improved evaluation process which contribute to ongoing improvements in content and delivery. The application of competency-based training, supported by safe, controlled, repeatable, and measurable simulation-based learning opportunities, is the right strategy to develop skills that can be used to cope with the complexity of the current and future defence environment.

Adaptive learning, also known as adaptive teaching or instruction, is an educational method which uses computer algorithms as well as Artificial Intelligence (AI) to orchestrate the interaction with the learner and deliver customized resources and learning activities to address the unique needs of each student. It is one of the most important advances in learning design.

The goal of adaptive instruction is to maximize educational effectiveness, including learner satisfaction, and learning speed (efficiency). Struggling students receive timely, scaffolded support to overcome challenges which, in the past, might have disqualified them. Students tend to learn more content more deeply (longer recall periods), to experience less dishonesty and cheating, and to be more engaged, motived, and successful in achieving their learning goals. To achieve success, adaptive learning structures must also overcome considerable challenges represented by limitations on subjective learning, startup costs, data privacy and security, and the potential for cognitive overload and disorientation.

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Distance education is an adaptive learning option which can reduce costs, time to train, and wear and tear on students. Specific design considerations must be followed to ensure successful outcomes; however, distance education has demonstrated impressive results in large-scale operations over vast distances and time zones. Distance education programs require novel approaches to testing and evaluation, as well as acceptance from learning leaders, practitioners, and administrators. Today's students have already accepted that remote learning is a viable option, though they need support and guidance to succeed and flourish.

## Strategic Imperative

As allied military forces struggle to adapt to rapid changes in technology and environment, transforming how we train and qualify warfighters has become a strategic imperative. Acquisitions programs may take years, and even decades, to deliver operational capability, and training systems to support use routinely lag deployment. Combatant commanders cannot tolerate these extended timelines.

If modern military forces expect to "fight like they train" in the 21st century, they must reimagine their current training pipelines and reconsider future training design. Strategically, the objective is to manage training capability over time, in the context of environmental factors and the organization's ability to respond to the changing environment and conditions.

Since militaries everywhere have already-existing training programs, it is crucial to evaluate where and how new methods, technologies, and systems can be best implemented, and the disruption minimized. A Learning Ecosystem should accommodate requirements for integration, flexibly, accessibility, modularity, and scalability.

Industry and academia have already done much of the heavy lifting with respect to the development of optimized tools and learning approaches, defining Learning Ecosystem designs and sharpening key technology capabilities. Achieving training success – measured by the right quantity of qualified warfighters at the right place, at the right time, with the right skills and abilities to deter or defeat any adversary – will require a combined effort between governments, industry, and academia. To confront what has widely been called "the most dangerous decade," training transformation is the key combat enabler.

The time to trigger the process is now.

## Conclusion

Meeting the challenges of modern defence requires more than just incremental changes to existing training programs – it demands a fundamental rethinking of how military personnel are educated and prepared for combat. Legacy training systems, designed for a different era, cannot keep pace with the rapid evolution of warfare, technology, and learning methodologies.

The adoption of Learning Ecosystems – integrating personalized learning, adaptive instruction, and digital tools – offers a scalable, efficient solution to these challenges. This approach not only improves the quality and speed of training but also enhances retention and adaptability among military personnel. Collaboration between defence organizations, private industry, and academia will be essential to implementing these changes at scale.

The future of military readiness depends on how effectively training systems evolve to meet new demands. Investing in modern, student-focused training models today will ensure that tomorrow's warfighters are better equipped, more capable, and better prepared for an increasingly complex battlefield.

At CAE, we equip people in critical roles with the expertise and solutions to create a safer world. As a technology company, we digitalize the physical world, deploying software-based simulation training and critical operations support solutions. Above all else, we empower pilots, cabin crew, maintenance technicians, airlines, business aviation operators, and defence and security forces to perform at their best every day and when the stakes are the highest. Around the globe, we're everywhere customers need us to be with approximately 13,000 employees in more than 240 sites and training locations in over 40 countries. CAE represents more than 75 years of industry firsts—the highest-fidelity flight and mission simulators as well as training programs powered by digital technologies. We embed sustainability in everything we do. Today and tomorrow, we'll make sure our customers are ready for the moments that matter.