Increasing demands on IT departments have resulted in unprecedented complexity for large-scale software development operations. The idea that traditional manufacturing practices could be used to reduce and manage complexity in large software operations has been tested and evaluated several times with varying degrees of success.
Hitachi was the first company to implement a Software Factory over 40 years ago in a venture that involved some 3000 personnel and spanned two decades. The evolution of the Hitachi Software Factory was influenced by the application of Lean service insights and principles as well as by the fundamental differences between software development and mass-production of physical products.

Hitachi Consulting continues to build upon the success and experience of the Hitachi Software Factories. Today our Global Development Centers employ some 2000 people and run over 100 programs. In addition to offering large-scale software development as an outsourced service, we help our clients develop and scale their own software development operations into something that we call the Lean Software Factory.

**Successful software operations will grow**

Large scale software operations are victims of their own success. Small operations that continue to deliver value to their customers will eventually grow. Small organizations are able to easily hone in on the demands and delights of customers, and align themselves to meet that demand. As demands grow and diversify, the effectiveness of the organization becomes challenged as it attempts to re-align itself and tune its operations. The more inertia that an organization has by virtue of its size and level of activity, the more difficult it is to realign. The continued effectiveness and growth of large organizations lies in their ability to understand and continually align themselves with their customers and markets.

**Agile software development in the large**

Agile software methods harness change for the customer’s competitive advantage. Since the declaration of the Agile Manifesto over a decade ago, organizations have been experimenting with Agile software engineering and project management practices in order to achieve this. Numerous studies and the overwhelming trend towards the adoption of Agile methods are testament to effectiveness in dealing with change; however the degree to which teams have been benefiting varies widely.

Many organizations have found that Agile frameworks such as Scrum work well for small, co-located teams, but struggle to apply them to larger and more distributed teams. Lean Software Development, on the other hand, has no preconditions related to the scale of operations and so is a better fit for the factory metaphor. The Lean value stream approach primarily addresses an organization’s mind-set and behaviors, establishing a culture from which a successful and scalable process grows.

**Process is easy, the rest is hard**

The techniques and ceremonies associated with popular Agile methods can take anywhere between a few weeks to a few months to put into practice. Many organizations consider their Agile transition complete once these practices are in place. The popular frameworks are treated as destinations, rather than the starting point or the means to more effective practices. The notion of these practices as “best” practices will either disappoint or limit the effectiveness of any Agile transformation. An important insight expressed by the original authors of the Agile Manifesto ten years after it was drafted, is that many organizations adhere strictly to the practices of popular Agile frameworks at the expense of creating new and better methods; organizations are “doing Agile but not being agile”.

At the heart of the Agile Manifesto and Lean Software Development, is the continuous discovery of better ways to develop software by experimenting and sharing the experiences with others. This requires a culture that reflects the values and principles of Lean and the various Agile methods; values such as courage, respect, and openness. The willingness to let go of externally derived “best” practices and the courage to find better practices is the defining quality of Lean organizations. Respect for the individuals and teams who display that courage, challenging conventions, and recognition that learning can only be preceded by a series of controlled failures is also a pillar of the Lean management philosophy. Lean organizations display a high degree of respect for the individual with the belief and trust that the people doing the work are in the best position to discover how to do it better.

Lean organizations not only give the workers the freedom to experiment and improve the flow of value in their processes, but they also empower them with the means to do so with the best tools and training possible. In other words, Lean organizations emphasize decentralization of decision-making capabilities to “front-line” workers that are most familiar with the customer context and required decisions. The people doing the work are not seen as people affected by the change, but rather as people affecting the change.
The Hitachi proposition

Hitachi’s experiment with applying factory methods to large-scale software development began in 1969 with Hitachi (Kanagawa) Software Works. By 1988, Hitachi had ranked first amongst its Japanese competitors in customer satisfaction and overall price performance.

Hitachi Consulting’s approach bringing together Lean and Agile organizational transformation methodologies is a reflection of Hitachi’s continuing evolution and continuous improvement. Hitachi Consulting offers this experience to customers through a comprehensive set of activities. Organizations are guided through a journey from prescriptive activities that demonstrate improvement as soon as possible, to embedding a culture of self-reliance delivering tangible and sustainable results.

The engagement begins with an Application Life-cycle Management (ALM) assessment. The ALM assessment uses a number of proven techniques to gather information on an organization’s people, processes, management system and tools. The observations are expressed quantitatively so that the results at different points during the transformation can be measured. Much of this data is locked in the ALM tools that the organization already uses. Hitachi consultants are able to generate valuable insights from ALM tools, allowing customers to make firm decisions based on a solid business case and compelling reasons to change.

Hitachi Consulting uses the information from the ALM assessment to chart a course from guided change to self-reliance. Copying the practices of successful teams without understanding the principles, values, and history behind the success of those practices will often lead to mediocre results. At the same time, there is merit in practicing elements of successful teams in order to gain a deeper understanding of the underlying principles. Hitachi’s approach offers teams the opportunity to experience those principles and values iteratively and incrementally through a journey from training to mentoring and eventually coaching, whereby clients are able to perpetually generate their own insights and initiatives.
Training
To ensure that the intentions behind Agile practices are well understood, Hitachi offers people the chance to try out Agile techniques and practices without the distraction and complexity of their work environments. This is in the form of the Scrum Alliance recognized Certified Scrum Developer (CSD) and Agile Project Management courses. The modules in the courses address all aspects of the software development life-cycle from product inception to the strategic handling of legacy code. The concepts target several levels and roles within the organization including senior management, Scrum Masters, product managers, testers, developers, business analysts and solution architects. The courses are taught using an iterative and incremental approach, whereby the same ideas and principles are visited repeatedly in the context of the various roles and in the technical and non-technical facets of software delivery. The modular design of the course allows it to be delivered on the customer’s site at a pace that suits the participants’ learning capability. The modules are also tailored to reflect the insights gained from the ALM assessment. These modules are offered in different tracks summarized below. Hitachi’s early experiences with Lean Software Factories placed learning at the center of the transformation. Poor performing factories expect processes and tools to make up for the inconsistency in skills and behaviors that drive high performance. In contrast, Hitachi’s approach favors developing people over developing processes. Our consultants go through an extensive training to ensure that they develop our clients’ people and the system they work in. This leads to a lasting and generative client capability to develop their own solutions.

### CSD Track 1

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### CSD Track 2

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### Agile Project Management

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Consulting, mentoring and coaching

Although self-organizing teams and empowerment for integrated decision making is absolutely essential for the Lean Software Factory, there is also a place for prescriptive direction. Hitachi Consulting draws from its global expertise to formulate solutions and recommendations that serve as a launchpad, allowing teams and individuals to get started with the transformation process quickly. Teams can become acclimatised and build a tolerance for the inefficiencies they experience day-to-day, and the observations made from an external and objective vantage point are invaluable. Traditional consulting activities extend the recommendations of the ALM assessment. They take a prescriptive approach and help teams acquire deeper understanding of the concepts that were acquired during the formal training exercises and simulations.

Learning by practicing is further facilitated by mentoring. Our consultants are seeded within client teams and during projects. They play a role in delivering to deadlines, within budget and within quality constraints, along-side other developers and testers on the critical path of projects. With their experience and insight, they demonstrate the art of what is possible within the constraints and complexity of the day-to-day work.

Finally, Hitachi consultants employ numerous coaching techniques to help teams create their own goals and the strategies to achieve them. These may involve numerous visualization techniques such as Kanban, Value Stream Mapping, Management Information dashboards and our Lean Pyramid. Retrospective decision making techniques such as our acclaimed User Story workshops and our Accelerated Decision Making workshops help teams formulate a series of achievable goals.

Large-scale change

Change is difficult – period. Large scale organizational change is harder because of the number of communication channels required to keep people engaged. Furthermore, the feedback channels are too few to know accurately whether change is happening. Change initiatives often focus on designing and communicating the new processes and organizational structure, and not on measuring the outcomes. As a result, successful change is often declared prematurely.

Change is preceded by learning. Without measurably substantiated behavioural change, Lean Agile transformations are reduced to the accommodation of new tools and terminology to old practices. In large organizations in particular, it is essential that change be driven mainly from outside-in (the value derived from the customer’s perspective) and below (from the people doing the work) and facilitated from above. When driven from the top only, organizational transformation too often begins and ends with the reorganization of organizational charts and a handful of new processes.

Hitachi Consulting’s approach to change within the Software Factory emphasizes application of feedback mechanisms. The feedback begins immediately with the ALM assessment. Hitachi works with the client to identify qualities that the organization would like to develop. A set of long-term strategies are identified which help the organization acquire those qualities. Then, a set of techniques that will help fulfill the strategic goals are selected. Teams can attempt the techniques immediately and expect success with them in the short term. In addition, a set of reusable exemplary artefacts are created such as documents or software components to help create consistency and provide a baseline for further improvement. Inspired by the Crystal Agile framework, these properties, strategies, techniques, and reusable artefacts, reflect the size of organization, its culture, the communication channels and the impact of software defects. Larger Software Factories with distributed teams have a stronger need for actively managed communication channels and ceremonies through a Management Control and Reporting System© than smaller co-located teams. Furthermore, life support systems require more rigor than gaming systems.

During the transformation to Agile and Lean methods, it is of the utmost importance to continuously evolve processes and the methodology itself, iteratively and incrementally. Each methodology and set of processes is a draft methodology for the next iteration. Hitachi calls this the “flexible factory”.

Hitachi Consulting is uniquely positioned to deliver large scale change because of our comprehensive offering of Technology Solutions, Managed Services, and Management Consulting. Because of our experience and centers of excellence in these three areas, Hitachi has an exhaustive toolkit in Lean, Change Management, Software Architecture, IT Infrastructure, Information Management and Quality Management. The effect is that the entire system and it’s value streams from inception to delivery is
optimized, while other competitors with a less comprehensive offering can only hope to create islands of efficiency.

**Scaling agile and the factory metaphor**

In recent years there has been a flurry of discourse within the Agile community about scaling Agile methods. Unfortunately the emphasis has been on the technical processes and project management rather than transforming mind-sets and behaviors. High performing traditional factories and production lines also require a transformation in culture or mind-set. They are set up to reduce dependency on un-skilled workers, through process automation and standardization. The analogy of the traditional production line is challenged when applying Lean principles in service industries, where the product is intangible. This is particularly true when applied to software development.

Unsuccessful attempts at modeling software factories on production lines have demonstrated that writing software is a creative and cognitive design activity. Applying Lean principles to drive out waste in physical product environments has been more successful in creating standardized tasks and sub-assemblies in mechanical and transactional processes. Software development teams in Software Factories must generate repeatable approaches that consistently deliver to the customers’ fluid needs viewing software development as a service rather than as a set of standard products. Rather than design components for reuse across projects, our Lean Software Factories supports growing our clients to reuse the creative design processes that teams have successfully developed. These successes are institutionalized across the organization until they are explicitly the way people work.

The effectiveness and efficiency of Hitachi Software Factories was not achieved through component standardization, but rather through the process of value stream standardization which resulted from harvesting the best innovations of the teams in charge of their own continuous improvement. The abundant data captured during Hitachi’s early experience with software factories shows that the increase in quality was achieved by increasing the level of competency of the workers in the software factories through a program of training, mentoring and coaching that resembled an artisan’s progression from apprentice through journeyman to master craftsman. New competencies ensure higher utilization of individuals, greater collaboration between individuals, resulting in higher quality and more satisfied customers.

The aim of Hitachi Software Factories was not only to provide a lower cost per unit of product. It was to establish a faster, more reliable and higher quality development service of product for all customers – by improving the way in which the product was produced.

**Application life-cycle management**

Many organizations see ALM as a means to control and standardize feed-forward processes in order to have better control over cost, time, and quality. Emphasis on feed-forward processes works well for traditional production lines that aim to reduce costs, decrease variability, and increase the output of identical parts. Lean Software Factories, however, ensure that the adequate feed-back mechanisms are also in place to facilitate continuous improvement.

Hitachi Consulting favors feed-back mechanisms and leverages its ALM and Management Information System, expertise to provide visualizations of process outcomes. Through feedback, the goals and direction that a team ought to take become obvious from the data and visualization.

This empowers the teams and provides them with the mandate to affect their own change. ALM is the cornerstone of Hitachi Consulting’s approach to the Lean Software Factory because, in large teams spanning many geographies and time-zones, the ALM platform is often the most effective means of communication. The success of the Open Source community in developing high quality products involving thousands of developers provides ample evidence of this. Finally, the ALM platform is a means of teaching. The successful practices and effective policies of a few teams can be communicated and scaled through process automation. Thus, with the appropriate feedback mechanisms, the production system itself prevents defects from entering the product or at least informs the users of any changes that would affect quality adversely. The high rate of churn on code shared by large teams requires more frequent integration to provide assurance that the software is usable.

Hitachi Consulting has a wide range of expertise in the development, integration, and customization of ALM tools. Historically, Hitachi Software Works developed several highly successful bespoke ALM and Computer-Aided Software Engineering (CASE) tools to assist in all areas of the Software Development Life-cycle. Today, several off-the-shelf ALM tools such as Team Foundation Server and the Atlassian ALM Suite offer comprehensive functionality that can assist with the entire application life-cycle, and that are also highly customizable.
Ultimately being able to continuously customize ALM tools and retune them to meet the needs of customers is an essential characteristic of the Lean Software Factory.

Fundamentally, Hitachi Consulting’s approach to ALM is first and foremost about building tools that are used to serve teams, by facilitating communication between individuals, and helping to scale and perpetuate patterns of practice that have proven to be successful through empirical evidence.

**The new software factory is a network of workshops**

For many companies that tried to imitate the Hitachi Software Works, the objective was to turn an artisan activity or craft into an industrialized production line. The Hitachi experience, however, proves that software development is indeed still a craft and creative process that requires the collaboration of highly skilled artisans and teams. Initially the approach overcame the shortage of numbers of skilled workers; then the accelerated learning environment rapidly developed the skills of workers – resulting in more skilled workers.

Metaphors are powerful and can be overloaded with meaning. The wrong metaphor can also be misleading. The factory analogy is accurate when used to describe the scale of operations and the objective to reduce variability in quality. However when it comes to reducing variability in processes and components, the factory metaphor must be treated carefully. Traditional western mass production factories produce products with a finite set of variations and hope it will delight and satisfy most customers’ needs and wishes. Software factories do not provide a finite range of standardized product, but a unique solution for each customer. The variability in functionality that a software factory must produce is as unlimited as the range of customers.

Software factories, like Lean manufacturers, first strive to understand what the customer wants and needs and then develop a solution. The Lean Software Factory is not a product factory; rather it is a service factory. Services are evaluated on how well they can meet a customer’s needs. Lean Software Factories provide a higher level of service which delivers to customers’ changing needs and respond quickly to changing markets.

The conclusions derived from Hitachi’s ground-breaking Software Factories are that the Lean Software Factory is a network of Workshops. They provide teams with the means to collaborate, share and continuously implement better ways of working for the benefit of customers.

**About Hitachi Consulting**

Hitachi Consulting is the global solutions and professional services organization within Hitachi Ltd., a global innovation leader in industrial and information technology solutions and an early pioneer of the Internet of Things. Hitachi Consulting is a business integrator for the IoT era and a catalyst for digital transformation. Using our deep domain knowledge, we strategically collaborate with our clients to help them innovate faster, maximize operational efficiency and realize measurable, sustainable business and societal value. As a consulting-led solutions company, we can help you leverage data as a strategic asset to drive competitive differentiation, customer loyalty and growth. To learn more, visit [www.hitachiconsulting.com](http://www.hitachiconsulting.com).