

**Clemson University**  
**BalancedFlow™**  
**Supply Chain Execution Concepts and Software Overview**  
*August 20, 2004*

**Summary**

Clemson University (CU) has developed unique and simple supply chain (SC) execution concepts and software that optimize profitability within one company or across entire SCs. Profitability is optimized through the minimization of stockouts at the end of the supply chain, the minimization of inventory across the SC, and the leveling of short-term and long-term manufacturing demand - *all at the same time*.

**Background**

The Department of Defense (DoD) provided the cornerstone funding for CU's advanced SC research and demonstrations. The original focus began in 1987 on apparel manufacturing technology and management practices through the creation of a fast-turn, model instrumented factory that produces approximately 1000 military and commercial shirts per week. It is one of the most modern sewn-products factories in the world with approximately \$3M of automated equipment provided at no cost by equipment manufacturers. CU's researchers search the world over for the most advanced sewn products technologies and management practices and integrate them into the model factory. CU demonstrates fast-turn manufacturing by producing shirts in 3 days in contrast to the industry standard of 4 to 6 weeks.

In 1996 CU led the DoD focus from manufacturing to SC execution because the untapped opportunities for improvement above the manufacturing floor totally dominate the opportunities on the floor. CU found that integrated Constraints Management, Lean Manufacturing, Six Sigma, and world-class teamwork concepts perfected for fast-turn manufacturing actually work even better for extended SCs due to the collaboration focus and multiplying effects of extending the concepts across functional and organizational boundaries.

Clemson continues to lead the very successful DoD SC implementation effort by rolling the concepts and software out to military clothing manufacturers. (The DoD project partners received the Vice President's Hammer Award in 2001 and the outstanding DoD Manufacturing Technology award for 2002.) Clemson implemented the first non-military version of the supply chain software in 2000 as a unique and extremely successful lean plant-scheduling tool and is making the concepts and software (collectively named BalancedFlow™) available commercially for lean production and SC scheduling of all types of items.

**BalancedFlow™ Supply Chain Execution Software**

BalancedFlow™ software is faster to implement with about 3 times more benefits than lean conversions within plants and it provides even greater results when applied to extended supply chains. Stock outs are essentially eliminated at the end of the supply chain, customer wait times and inventories are reduced by over 90 percent, and manufacturing costs are reduced by 5-20 percent. *Achieving inventory balance, making the right items, and making the right items fast are the keys to these extraordinary results.*

BalanceFlow™ is a new SC execution concept that results in these radical improvements. All other SCM efforts consist of better systems, forecasting, and order generation that, if totally successful, can only result in incremental improvements in old business practices. BalancedFlow™ consists of a new non-sequential SC operational methodology and supporting software that together maximize single plant or total SC performance. It is named BalancedFlow™ because it first *balances* all the inventories in the SC in days-of-supply and it then synchronizes and maximizes the velocity of product *flow* down the entire SC based on daily consumer pull. (Forecast-based push scheduling is virtually eliminated by this pull scheduling.)

The goal of the BalancedFlow™ SC is to maximize profits by multiplying revenue and minimizing costs across the entire SC for all participating partners. The goal is achieved through the three primary business

objectives of eliminating stockouts at the end of the SC, minimizing inventories across the SC, and minimizing manufacturing demand variations. ***The driving focus and primary measurement is the “cash to cash” throughput time and the ultimate limiting factor to achieving minimum throughput time is changeover times on the bottleneck processes in the manufacturing and shipping sections of the SC.*** Throughput time is defined as the days required to convert money invested in inventory coming into the SC into new money through sales to the consumer at the end of the SC.

The BalancedFlow™ concept is implemented through Web-based BalancedFlow™ SC execution software that re-balances inventories and accelerates the flow of replenishment stocks in shortest supply down the entire SC as frequently as daily based on total asset visibility, six jointly established business rules, and consumer-driven demand pull. SC balance is achieved when multiple items at different inventory levels and consumption rates are expected to meet consumer demand for the same number of days. When balance is achieved, the risks of stockouts and excess inventories are equalized and only then can stockouts and inventory costs can be minimized for all of the items in the SC.

Once SC balance is sufficient to eliminate stockouts at the end of the SC, inventories across the supply chain are minimized to maximize throughput velocity. The first step in maximizing throughput velocity is mapping strategic buffers and SC segments. Each SC segment contains a process, the process' supporting buffer of waiting work, and the buffer's replenishment module. The replenishment modules may be internal or external to the segments, formal or informal, but they always exist or else processes run out of work and efficiencies cannot be maintained!

Strategic SC segments are the few segments that must retain buffer inventory to protect the SC's consumers (external constraints) and manufacturing bottlenecks (internal constraints) because this is more important than throughput speed. Strategic SC segments are next converted into three primary types of SC sections; shipping, manufacturing constraint, and manufacturing gate. These three types of sections encompass non-strategic segments and are repeated for each SC partner as we move up the diverging branches of the supply network. The BalancedFlow™ software re-prioritizes the work released from these few strategic buffers daily after legacy system batch updates to rebalance all downstream strategic buffers. The balanced mix of strategic buffer inventories then permits the release of the items most needed downstream.

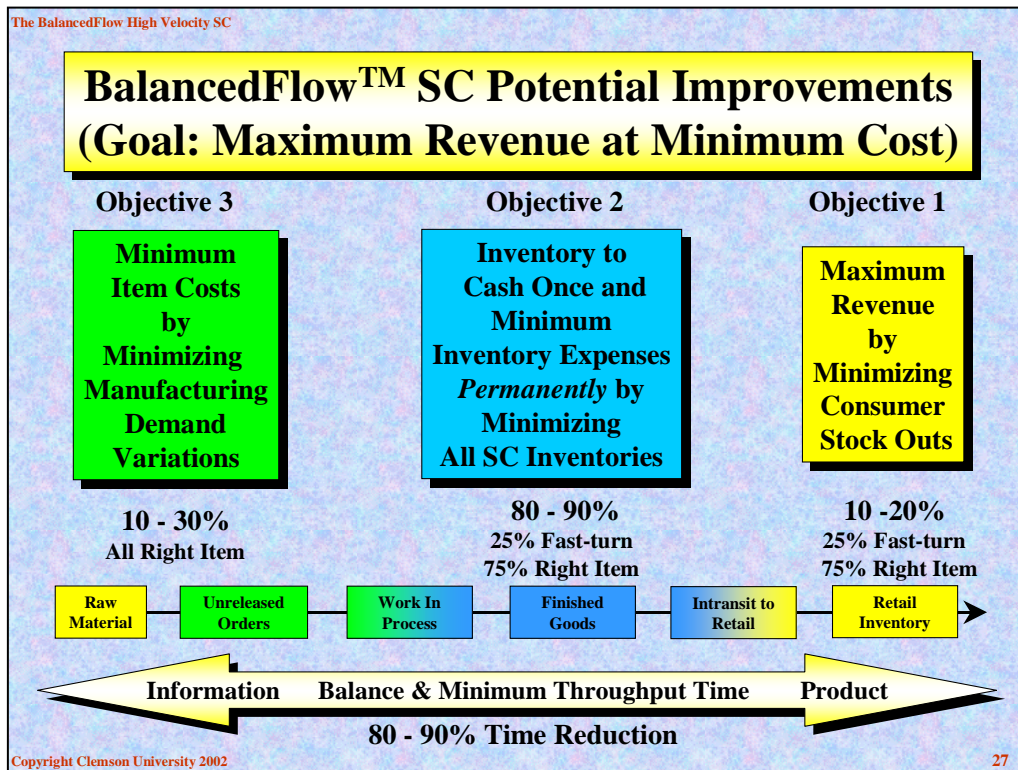
Non-strategic SC segments are the many segments whose buffers are reduced to minimum transfer batches and whose transfer batches are minimized to maximize SC-wide throughput. Process owners use world-class teamwork, constraints management, lean, and six sigma concepts and tools to accomplish this. The focus is first on reducing changeover times on bottlenecks so transfer batch sizes can be minimized at no increased operational expenses. Faster throughput between strategic buffers, in turn, permits the further reduction in the size of strategic buffers resulting in even faster throughput and lower quality costs. ***BalancedFlow™ SC throughput is defined as the rate at which incoming products are converted into cash through consumer sales*** in contrast to traditional local optimization definitions such as production lead-time, replenishment lead-time, order-ship-time, economic order quantities, re-order points, product cost, and especially budget-driven “manufacturing efficiency.”

BalancedFlow™ uses balanced inventories and high velocity throughput to optimize supply chain performance by minimizing stockouts, inventories, operational expenses, and manufacturing demand variations, ***all at the same time***. BalancedFlow re-balances the entire SC from each strategic buffer forward as frequently as on-hand inventories can be refreshed (normally daily) by activating resources only for items that are in shortest supply down the entire SC (in contrast to all traditional sequential solutions). Stated differently, a BalancedFlow SC maximizes balance and throughput velocity by (1) automatically, daily, and in synchronization accelerating the items that will turn into cash the fastest across the entire SC and (2) freezing all other work in place. ***This constantly corrects for forecast errors and thus trivializes the importance of the forecast and its associated errors for supply chain execution.***

As balance is achieved and throughput velocity is increased, many secondary objectives such as working capital requirements, interest expenses, consumer wait times, product offerings, and expedite shipping costs are optimized. The traditional and costly non-value added replenishment processes are eliminated.

BalancedFlow™ is cutting-edge supply chain execution software that is built upon a proven foundation of SC statistics and integrated concepts from Six Sigma, Constraints Management, Lean Systems, and world-class teamwork. BalancedFlow™ was developed over a number of years in real SCs in which Clemson University and commercial manufacturers produced items for Marine Corps basic training at Parris Island.

BalancedFlow™ SC software coupled with fast-turn manufacturing and shipping enables any SC to (1) order/make/ship the items most needed first (2) as fast as possible. Together, BalancedFlow™ software and fast-turn manufacturing/shipping can improve production lines or SCs radically by minimizing consumer-level stockouts, minimizing throughput times and inventories, and reducing replenishment, manufacturing, and shipping costs. About three-fourths of the potential improvement comes from making/shipping first the items most needed and the other one-fourth comes from making or shipping the most needed items fast. A typical supply chain and the sources of these radical improvements are shown below:



BalancedFlow™ software does not replace legacy software (it can replace scheduling modules within existing software systems); it is a Web-based tool that receives inventory data from legacy systems and provides prioritized recommended move/ make (or order) actions at the part number level back to strategic SC section owners daily. It works within a single plant or across entire supply chains. Within a single plant it is the ultimate in Lean Scheduling for part or all of the plant and it eliminates traditional replenishment practices and associated costs/delays by generating automatic replenishment purchase orders based on available funding while minimizing on-hand inventories.

A pilot project consisting of one family of items and one to three SC partners can be implemented for evaluation in one workday. Supply chain science and the BalancedFlow concepts can be conveyed in detail to supply chain stakeholders in a 3-4 hour seminar. A 1-2 hour workshop can then be conducted to map the pilot SC, identify the items and operational parameter values. Initial data can be obtained and uploaded in a couple of additional hours and the software can be demonstrated and evaluated to determine the potential business impact on the production line or SC partnership. Training and expansion normally require one to two additional weeks of outside assistance with one full time internal project manager.

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