TRANSFORMING OPERATIONS FOR MASS CUSTOMIZATION

Specific steps card issuers can take to maximize small job efficiency and gain a competitive advantage

DatacardGroup
SECURE ID AND CARD PERSONALIZATION SOLUTIONS

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SECTION 1. ISSUE OVERVIEW

Shorter product lifecycles. Smaller production runs. Shorter turnaround times. Tighter profit margins. Tougher regulatory requirements. Increasingly competitive markets. These dynamics are forcing successful card bureaus to reconsider the way they manage their operations.

Relatively recently, operations were managed much differently. Card issuers offered one to 10 card products. Customers placed orders by the batch, and issuers consolidated all the orders for one card product into a single job. Issuers managed a handful of unique production runs that may or may not have included various card carriers, envelopes and inserts. Because there were few product groups, issuers typically ran very large batches of each group.

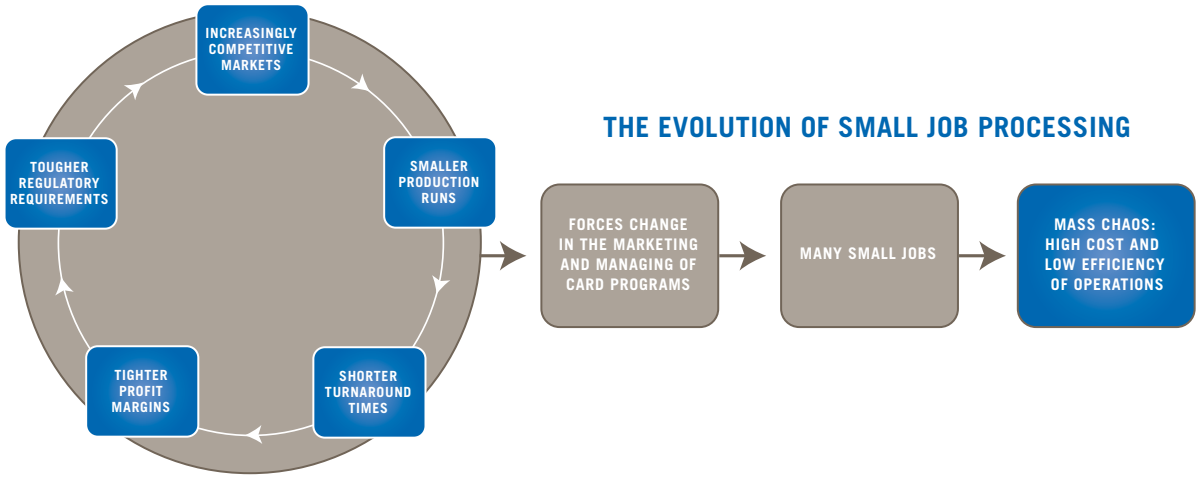
Today, large production runs are no longer the norm. Card issuers have become experts at product development and brand management, targeting increasingly specific customer needs and interests with unique card products and card designs. Requests for new cards are spread across a thousand designs, resulting in very small batches — often as few as three cards. Like many other industries, the card market is moving from mass production into mass chaos, with production teams facing the growing challenge of producing smaller and smaller batches with greater and greater efficiency.

In production environments designed to handle large jobs, small batches increase waste and reduce efficiency. Supervisors note that systems are often idle, despite significant backlogs. Lower efficiency for small jobs makes it difficult to commit to production schedules. Stacks of cards and paperwork add to the confusion. Increased complexity and the need for manual intervention raises the risk of errors and quality issues. Costs are also increasing as issuers hire more people to manage larger inventory, acquire more storage space, scrap more jobs when changes occur and manage the design process for thousands of cards, forms and inserts.

Forward-thinking issuers understand that improving the efficiency of small job processing will deliver a significant competitive advantage. Services must be aligned with customer needs, and those that can satisfy these new demands at a competitive price will thrive.

The key to this improvement is mass customization: issuing cards to meet individual customer needs with efficiency comparable to mass production, through a unique combination of processes, systems, proactive management and automated data collection.

Mass customization can seem complex. However, there are ways to simplify the process, minimize costs and maximize return on investment. Datacard Group can guide you through the process of optimizing production for mass customization. This white paper provides an overview of efficient small batch processing and the solutions required to realize the benefits of mass customization.



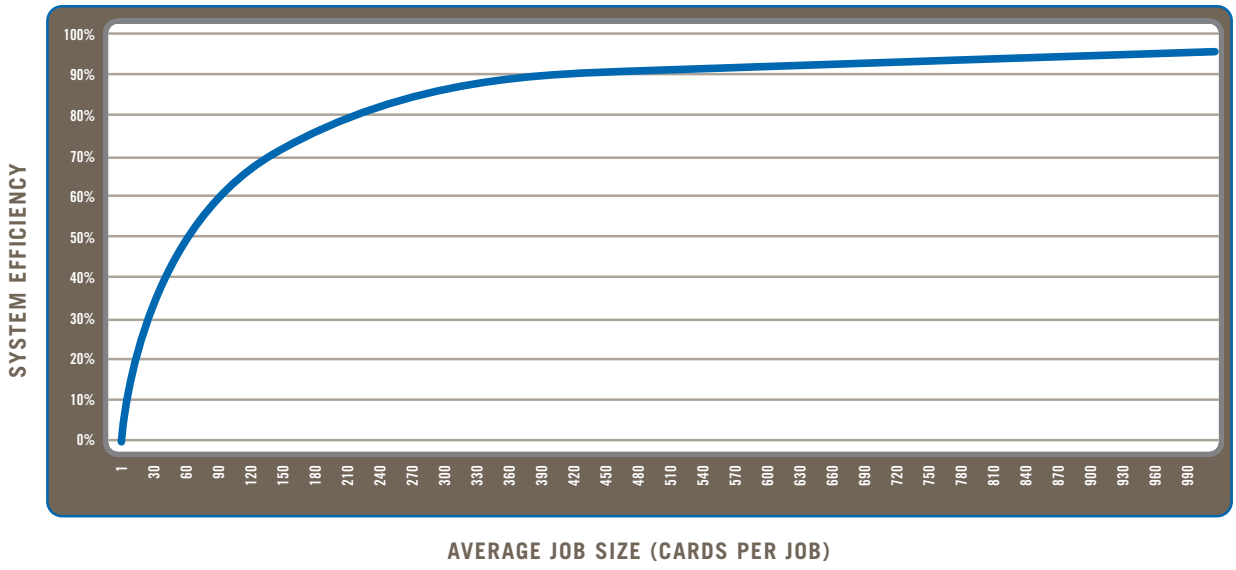
SECTION 2. HOW JOB SIZE AFFECTS EFFICIENCY

As market dynamics continue shifting toward shorter product lifecycles, smaller production runs, higher quality and more complicated regulatory requirements, the need for change is clear.

Increasing the rated speed of production systems — the primary way to increase the efficiency of large job processing — is an insufficient solution in environments with an abundance of small jobs. Focusing on system speed alone, without considering all the factors that affect operational performance, is an incomplete approach. In fact, higher rated speeds will have very little impact on the overall time required to process cards in some cases. To maximize efficiency in environments with increasingly shorter production runs, card issuers need processes and solutions specifically designed to improve small job efficiency.

To optimize the efficiency of any process, it is important to study the process and identify wasted effort or resources. In the case of card personalization, waste occurs any time there is a backlog of work and production systems are idle.

Every job released to the floor requires a number of production tasks. These may include pulling and double-counting the card stock, creating job tracking paperwork, communicating with production workers about the priority of the work, setting up supplies on equipment, starting up the equipment, verifying work completed and documenting work progress or status. There is also non-production time spent filling the track with cards at the start of each job and restocking or changing inventory and supplies. Many of these tasks take the same amount of time regardless of the size of the run. As production runs shrink, the amount of time in a job required for non-production steps grows as a percentage of total job time, resulting in lower efficiency. The following chart shows the relationship between efficiency and job size (see caption for the calculating formula).



Efficiency is a function of Job Size, Maximum Rated Throughput, Track Fill Time and Job Select Time. This relationship can be expressed through the following set of calculations:

Theoretical Efficiency = *f*{Job Size, Maximum Rated Throughput, Track Fill Time, Job Select Time}

Job Run Time = Job Size / Maximum Rated Throughput

Total Job Time = Track Fill Time + Job Select Time + Job Run Time

Effective Speed = Job Size / Total Job Time

Theoretical Efficiency = Effective Speed / Maximum Rated Throughput

SO:

$$\text{Theoretical Efficiency} = \frac{\text{Job Size}}{\text{Track Fill Time} + \text{Job Select Time} + (\text{Job Size/Maximum Rated Speed})}{\text{Maximum Rated Speed}}$$

For more information about calculating theoretical efficiency, please refer to Datacard Group's white paper: "Manufacturing Efficiency Measurement in Card Personalization Operations."

The following chart summarizes data from actual card production facilities. The data reflect the total time spent over the course of a three-hour shift and include multiple jobs of each job size.

JOB SIZE	SETUP TIME	TRACK FILL	PROCESSING	TOTAL	EFFICIENCY
1 TO 5	66.1	33.0	6.6	105.7	6.3%
6 TO 10	7.6	3.8	2.0	13.5	15.1%
11 TO 15	3.5	1.8	1.5	6.8	22.4%
16 TO 20	1.7	0.8	1.0	3.6	28.6%
21 TO 25	1.3	.07	1.0	3.0	33.8%
26 TO 30	2.2	1.1	2.0	5.3	38.4%
31 TO 100	1.9	0.9	4.1	6.9	59.3%
101 TO 200	1.7	0.9	8.6	11.2	77.0%
201 AND UP	1.2	0.6	23.9	25.7	93.0%

Based on the data, jobs of fewer than 20 cards achieve less than 40% efficiency. Compare that with jobs of more than 200 cards, which achieve 95% efficiency. The data only include the non-production tasks associated with machine setup, inventory and supplies. Results would be even more pronounced if they included time for prioritization, verification and documentation of work progress.

So what are the implications for card issuers in terms of real output? Consider this scenario: A customer calls a service bureau at 8:00 a.m. and needs 10,000 cards completed by 5:00 p.m. The bureau's current systems have a rated speed of 2,000 cards per hour, and there is one system available for overflow work.

If these cards are all the same product, there will not be a problem. One large job has very little overhead. It will take approximately five hours and 15 minutes to complete the work using the single overflow production system.

But what if the orders came from the customer's online ordering system, and they are for a variety of card products in batches of 10 or fewer cards? Based on the efficiency calculation above, it will take at least 20 hours to complete this work on one production system — almost four times longer. The bureau will not be able to finish the job on time without

delaying work on another production system.

The bottom line: when many small jobs are grouped together, they have a much larger percentage of idle time than the same number of cards in a single, large job. As a result, small jobs tend to compromise efficiency, raise costs and lengthen turnaround times.

SECTION 3. CARD OUTPUT VS. SYSTEM THROUGHPUT

To maximize the number of cards produced per day in a small job processing environment, issuers must look beyond the rated speed of personalization equipment and focus on the actual output (measured in cards per hour) that can be achieved. Rated speed is based on how fast the system produces cards during operation, and does not take into account idle time for process steps, new setups, supply changes, inventory restocks, misfeeds and other errors or machine downtime.

To illustrate the impact of rated speed in both large and small job processing, consider the bureau above that is running large jobs. With a rated speed of 2,000 cards per hour, the bureau can expect output of approximately 15,200 cards in one shift. At 95% efficiency, the best way to increase total card output is to increase production system speed. The greatest gain that can be realized by improved efficiency is 800 cards per day, while a 10% increase in raw speed will result in an additional 1,520 cards per day.

Now consider a bureau that has an average of 10 cards per production run. According to the actual data shown above, this shop would achieve approximately 25% efficiency. With a rated speed of 2,000 cards per hour, the output during one shift will be approximately 4,000 cards. A 10% increase in raw speed will result in an additional 400 cards per day. However, if efficiency could be increased to 50%, this would result in an additional 4,000 cards per day. If small job processing reached the same efficiency levels of large job processing (95%), this would result in an increase of 11,200 cards — nearly three times the current capacity with no increase in production speed.

CURRENT STATE

	RATED SPEED	CURRENT EFFICIENCY	OUTPUT PER SHIFT
BUREAU A	2,000 CPH	95%	15,200 CARDS
BUREAU B	2,000 CPH	25%	4,000 CARDS

INCREASING SPEED

	RATED SPEED +10%	OUTPUT PER SHIFT	IMPACT PER SHIFT
BUREAU A	2,200 CPH	16,720 CARDS (95% EFFICIENCY)	+1,520 CARDS
BUREAU B	2,200 CPH	4,400 CARDS (25% EFFICIENCY)	+400 CARDS

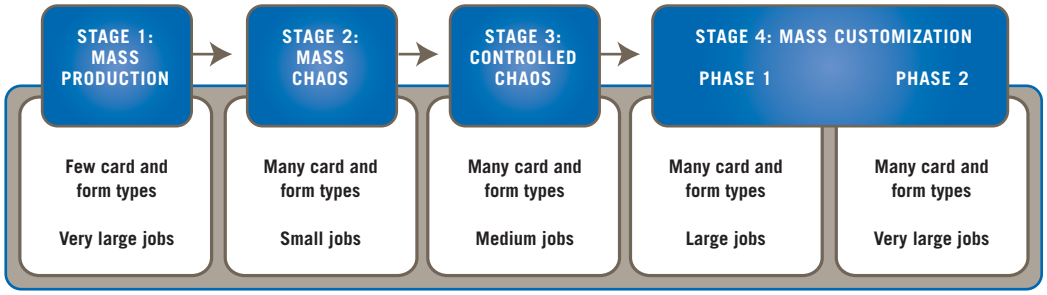
INCREASING EFFICIENCY

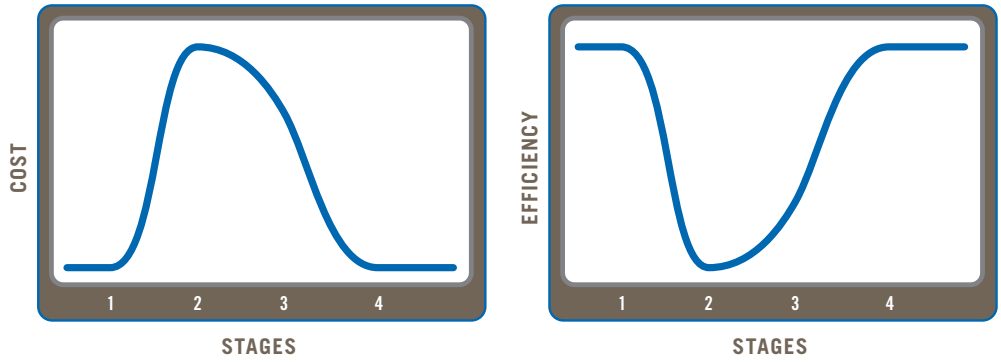
	FUTURE EFFICIENCY	OUTPUT PER SHIFT	IMPACT PER SHIFT
BUREAU A	100%	16,000 CARDS	+800 CARDS
BUREAU B	50%	8,000 CARDS	*+4,000 CARDS*
	95%	15,200 CARDS	*+11,200 CARDS*

SECTION 4. FROM MASS PRODUCTION TO MASS CUSTOMIZATION

The evolution from mass production to mass customization often occurs incrementally, as organizations move through the different stages of production. Issuers with minimal variability in card and form types are in the first stage, and they enjoy high-efficiency production with traditional card issuance solutions for very large jobs. Most customers, however, have greater variability in card, form and insert types. Instead of high-efficiency production, they are producing fewer cards per day at a time when customers expectations are rising. This problem is not inevitable. Issuers can meet customer needs for customized cards and fulfillment packages and enjoy a high degree of production efficiency. To do this, issuers must take advantage of new systems, processes and tools.

The four stages of evolution are:





Stage 1: Mass Production

The first stage consists of a traditional environment with a small number of card products. Inventory management for card stocks, personalization supplies and fulfillment materials can be handled by automated systems. Shortages and large overruns of inventory are uncommon. Quality checks can be made at high increments. Systems and operators operate at high efficiency, with cards per hour approaching rated speeds.

Stage 2: Mass Chaos

In this stage, card issuers create highly targeted products to grow market share. The number of unique card styles grows from tens to hundreds for some, and from hundreds to thousands for others. Inventory management becomes difficult as card types soar and new products are added at an increasingly rapid pace. Accurate forecasting of card stocks and fulfillment materials is nearly impossible. Carrying higher inventory levels is prohibitively expensive, and with chip cards becoming more prevalent, inventory costs are expected to grow to 10 times their current level.

The production environment is still operating with the same processes, systems and tools that were originally designed for mass production. Unfortunately, effective solutions for mass customization are fundamentally different than traditional card issuance. In a mass customization environment, high capacity utilization and high inventory levels become obsolete.

As a result, efficiency rates plummet as job sizes become smaller, while issuers must invest in more systems and operators to maintain current daily card output levels. Inventory management becomes even more challenging as issuers forecast a variety of card stocks and order them in small quantities. Scrap inventory increases as forecasting accuracy declines. The need for quality checking increases and labor costs go up.

Stage 3: Controlled Chaos

In this stage, production efficiency begins to rise as issuers change some processes and systems to better suit a mass customization environment. Traditional card operations with large batch processing techniques rely on large batches to spread setup times across large quantities of cards. For small job processing, however, efficiency can be increased by minimizing the non-production time associated with each batch. Steps that must be repeated for each batch (changing supplies, downloading data, setting card parameters and filling the card track) hinder efficiency as batches approach one card. As issuers significantly reduce or eliminate setup times, cards are made to order as orders arrive, with the same efficiency currently achieved with large job processing. To do this, issuers automate the selection of setups for production systems, combine similar jobs, create rainbow decks and implement other process and system changes. As a result, operations begin to increase efficiency and minimize errors.

Stage 4: Mass Customization

By dramatically reducing the need for offset-printed card stocks and preprinted fulfillment materials, issuers can significantly improve customer flexibility and reduce costs. Offset printing, while extremely efficient for very large quantities, is much less efficient for small batches. As a result, issuers purchasing lower volumes of cards face higher costs and slower delivery from card suppliers. Printing cards as needed (with print-on-demand technology) enables issuers to purchase card stocks in very large quantities, reducing both cost and lead time. The number of card stocks in inventory can be significantly reduced. This simplifies inventory management, reduces scrap and significantly lowers inventory costs. Card stock inventory and purchasing are handled by automatic resupply techniques. Quality control inspection involves one or two types of cards, rather than hundreds or thousands. These changes, combined with the process and system changes made during Stage 3, allow issuers to combine many smaller jobs into fewer large jobs and enjoy the same production efficiency normally associated with mass production environments.

SECTION 5. TWO METHODOLOGIES FOR AUTOMATING PRODUCTION SYSTEMS

There are two ways to significantly reduce operator involvement in setups for production equipment: the Dynamic Setup Method and the Data-Driven Method. Card issuers can choose one or the other, or employ a combination of the two.

Dynamic Setup Method

The Dynamic Setup Method is the easiest way to automate production systems. It does not require any data changes at the record level. Instead, production systems that support this capability will automatically choose the job setup (or the card setup) based on criteria specified in the job data file name and folder path, or the file identification record (FIR).

Using the Dynamic Setup Method, issuers can eliminate the need for operators to manually select a job setup at the start of each job, which helps reduce total setup time.

The first step in the Dynamic Setup Method is automating job setup selection. With criteria specified in the job ID or FIR, the production system automatically selects a job setup. (Operators still need to combine jobs manually or use a tool such as Datacard® Syntera® manufacturing efficiency software for optimal job combinations.)

The next step is to automate the card setup selection. This requires the addition of an indicator in each card record that specifies a card setup. The production system automatically selects a card setup to match the criteria specified in the card record. Criteria can be based on an existing data field, or a new data field can be added. This enables organizations to build larger, more complex jobs, reduce setup times and waste and eliminate the need to manually combine jobs.

The Dynamic Setup Method enables bureaus to gain some of the efficiencies associated with automated system control - without changing any data. This eliminates a source of error and improves efficiency. The disadvantage of this method is that it requires greater administration within operations. For example, setups must be managed manually and operators may have to combine jobs. As unique product types and variables increase, the use of the Dynamic Setup Method becomes more complex and labor-intensive. For this reason, the Data-Driven Method is recommended as a long-term solution for large, complex environments.

Data-Driven Method

The most effective method for automating production systems is to add elements to each data record that control the behavior of the production system. This process — combined with flexible production systems that can act on the data — enables production systems to change card attributes dynamically, without stopping or requiring operator intervention. Systems can run several unique products as a single job with the same setup, effectively eliminating the waste associated with running several small jobs, each with its own setup time. This method requires very little administration at the operational level. Decisions are determined by the data, not by production operators. The benefits are significant: fewer errors and much higher efficiency for small jobs.

The Data-Driven Method can be implemented in stages. First, issuers can use data at the card record level to drive a module change or an element change. A module change occurs when card data specify which input module to select or which topping module to use. An element change occurs when card data specify a change in a logo or font. Using this approach, bureaus must modify production data to include the attributes that the data will control. The amount of data that can be utilized depends on the flexibility of the production system; the more data elements that can be controlled dynamically, the more unique products can be run as a single job.

The Data-Driven Method, used in conjunction with appropriate hardware, can also automate card stock verification. In this case, card stock ID numbers are added to the card record and used with a vision verification module to automatically verify that the card supply matches the required stock. This capability supports job combination by reducing the risk of errors that can occur during the uninterrupted processing of many different card products using a variety of card stocks.

Finally, to reach highly efficient mass customization, the Data-Driven Method can be used with printing devices to produce unique cards and fulfillment packages on demand, as actual orders dictate. At this stage, bureaus can issue one-of-a-kind card products with efficiency comparable to traditional mass issuance. By printing the card stock to order, issuers can significantly reduce card stock inventory, reduce time spent pulling and arranging card stocks for production, and eliminate errors associated with loading incorrect stock.

SECTION 6. STEP-BY-STEP PLAN FOR ACHIEVING MASS CUSTOMIZATION

Despite the changes required to realize the advantages of mass customization, card issuers can improve operational efficiency over time while protecting current investments. Many issuers can benefit simply by taking advantage of capabilities current systems already offer. Others can make new investments in systems and processes that offer superior techniques for overcoming the challenges of small batch processing. In either case, the first step is the same.

Step 1: Evaluate Your Efficiency

The most effective way to improve any process is to perform an in-depth assessment. Documenting actual process steps, including tracking times for all activities — setup, stock changes, supply changes, track fill, etc. — will help identify wasted effort, bottlenecks and other inefficiencies you can target for improvement. (For a complete overview of how to assess and measure operational efficiency, please see the Datacard Group white paper "Manufacturing Efficiency Measurement in Card Personalization Operations.") Datacard Group can work with you to perform a production audit that will identify problem areas and identify recommendations for improving operational efficiency. When you contact us, you can expect first-rate knowledge and expertise in small job efficiency calculations and solutions.

Step 2: Determine Your Approach

There are several considerations that determine whether you should improve efficiency using the Data-Driven Method, the Dynamic Setups Method or a combination of the two. Issuers that already have an abundance of unique products and very small jobs will see the best results by fully implementing the Data-Driven Method. However, issuers with a backlog of critical data processing needs (which make it extremely difficult to realize changes in a reasonable timeframe) should implement solutions based on Selection Criteria.

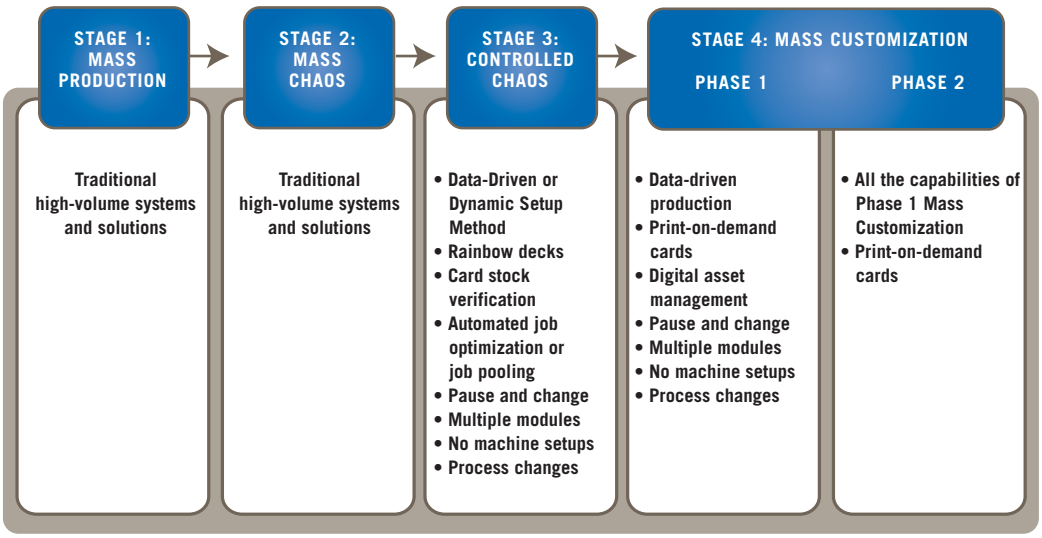
Step 3: Take Advantage of Existing Capabilities

Many issuers do not take advantage of all the capabilities current production systems have to offer. For example, the Datacard® 9000 Series card issuance systems already have the ability to combine jobs and increase efficiency using data-driven functions. These functions enable users to combine smaller jobs into a single large job, then use data elements to automatically select input modules, magnetic stripe coercivity levels, graphics modules, topping modules, laminate modules and many card delivery functions.

Step 4: Invest in Solutions Designed for Small Job Efficiency

Some systems are designed for demanding small job processing environments, while others are designed for high-volume, large batch processing. Datacard Group has long been on the front lines of the battle for small job efficiency. We introduced the first data-driven card issuance system (the Datacard 9000 Series system) more than 15 years ago. Datacard Group has continued to introduce hardware and software products that help improve efficiency, culminating with the launch of the Datacard® MX6000™ card issuance system in 2006.

The investments issuers need to make depend primarily on where issuers are today in the evolution toward mass customization (see the chart below). Issuers with little variability in card and form types can continue to use solutions designed for mass production of large jobs and enjoy high-efficiency production. Most issuers, however, are already dealing with a proliferation of card, form and insert types, which puts them in either Stage 2 (mass chaos) or Stage 3 (controlled chaos). Issuers facing these challenges can increase efficiency and reduce costs by making investments that will move them to Stage 4. Of course, issuers can also skip stages at any time by implementing the most efficient processes and systems available.



To move away from the mass chaos common in Stage 2, organizations can invest in technology to increase job size and decrease the time spent between each job. Intelligent hardware platforms designed for small job processing environments provide the foundation for efficient production by enabling the consolidation of many unique card products into a single production run. The most advanced systems available offer a variety of capabilities. Here are some specific features organizations should look for before making a final decision.

System Design

Production systems designed for small job processing environments are very different than those designed for mass production. Maximizing daily card output in a small job environment will depend less on system throughput and more on a system's ability to minimize setup and track fill time. Whether you implement all of a system's capabilities immediately or in the future, choosing systems designed to support mass customization will protect your investment. To find a system designed for small job processing, look for the following capabilities:

- Data-driven intelligence
- Dynamic setups
- Automated machine setups
- Dynamic supply changes (no new setups or track clearing required)
- Multiple module support
- Job pooling support
- Automated supply verification
- Automated card stock verification
- Print-on-demand card stock

Automated Production

Automating card and job setups can be achieved through the Dynamic Setup Method, the Data-Driven Method, or a combination.

- **Dynamic Setup Method.** One of the easiest features to implement is dynamic job and card setup. Systems with this feature enable users to produce cards with different features in a single production run — without requiring operators to select a new job setup or card setup, or stop the system entirely. Examples of changes made dynamically include variations in logo placement or font type.

  With dynamic job setup, the production system automatically selects the job setup to match criteria specified in the job data file name and folder path (or in the FIR). If the personalization system supports this feature, the

only step required to implement dynamic job setup is adding an indicator in the job data file name or FIR. In other words, no data changes at the record level are required. However, operators still need to combine jobs manually or use a separate optimization program for job consolidation.

Next, issuers can extend dynamic setups to include card setup. Here, the production system automatically selects the card setup based on criteria specified in the card record. Criteria can be based on existing or new data fields. As with job setups, issuers will need to add an indicator in each card record. Eventually, dynamic card setup enables issuers to create larger, more complex jobs, reduce setup times, minimize waste and eliminate the need for manual job consolidation.

Some systems already have these capabilities. The Datacard MX6000 system, for example, provides dynamic job and card setup through the Selection Criteria feature. This feature allows multiple jobs with different card setups to be run together without stopping the system, creating a new job or emptying the track of cards.

- **Data-Driven Method.** With the Data-Driven Method, issuers can achieve higher efficiency by adding elements to each data record that control the personalization process. This method requires systems designed to recognize and react to intelligence within data records, as well as change card attributes without stopping or requiring operator intervention.

  The Data-Driven Method eliminates many operator steps, allowing systems to run several unique card products as a single job. It requires very little administration at the operational level, because decisions are determined by embedded data instead of by production operators. Consequently, issuers that implement this method should see dramatic improvements in efficiency and a corresponding reduction in errors.

  Only the most advanced systems can interpret intelligence in the data record and then determine what supplies are needed for the entire job, choose product setups on a record-by-record basis and verify the accuracy of card output. These systems can handle the following functions without new setups and without clearing and refilling the card track (which significantly reduces waste):

  - Changing card stocks
  - Changing topping foil colors, ribbon colors and label supplies
  - Reloading supplies
  - Variable inserts
  - Output sorting
  - Logo changes
  - Graphics, color or label locations
  - Card stock verification

When using Datacard® card issuance systems, the following options can be data-driven:

	NEW GENERATION MAXSYS, MX6000	LEGACY 9000/7000
INPUT MODULE SELECTION	●	●
POOLING INPUT MODULES	●	
MAGNETIC STRIPE COERCIVITY LEVELS	●	●
EMBOSS LOCATION AND FONT	●	LINE
LABEL MODULE SELECTION	●	●
LAMINATE MODULE SELECTION	●	●
LAMINATE FOIL ID	●	
TOPPING MODULE SELECTION	●	●
TOPPING FOIL ID	●	
SELECTABLE FOLD TYPE	●	●
SELECTABLE INSERTS	●	●
OUTPUT MODULE SELECTION	●	
POOLING OUTPUT MODULES	●	
LABEL PRINTING LOCATION	●	
LABEL SUPPLY NAME	●	
GRAPHICS LOCATION	●	●
GRAPHICS RIBBON NAME	●	
GRAPHICS ROTATION	●	
COLOR PRINTING LOCATION	●	●
COLOR PRINTING RIBBON NAME	●	
COLOR PRINTING ROTATION	●	
COLOR PRINTING TEXT COLOR	●	
CARD STOCK VERIFICATION	●	

The more data-driven elements you have, the more you will be able to minimize operator intervention and maximize efficiency. If changing data is difficult, issuers can evaluate current card products to see which attributes require the most system stops. These attributes will be the highest priority for automation via data-driven production.

Minimal Changeover Time

Systems can minimize the time required to change or add supplies or card inventory in two ways.

- **Pause and change features.** Intelligent production systems automatically pause and prompt operators to add or change supplies or card inventory — without requiring new setups or card tracks to be emptied and refilled. This capability supports data-driven consolidation of jobs with dissimilar characteristics into a single large job. The only non-production time is inserting stock when the system pauses. No card setup or track fill time is required. Systems should also be designed for quick, easy supply changes.

  When the data-driven attribute of a supply type or card stock ID is implemented, the Datacard MX6000 system Pause and Change feature automatically compares the supply requirement in the data record with the RFID tag on the Datacard® Certified Supplies item loaded in the module. If the supply requirement does not match the supply loaded, the system automatically pauses and prompt the operator to load the correct supply. The system pauses without emptying the track, eliminating the time associated with track emptying and refilling.

- **Multiple modules.** Systems that support multiple modules give issuers another way to minimize changeover time. Multiple input and output modules allow operators to use separate modules for different card types, then combine jobs with different card stock requirements into a single job — without a new setup. Systems with multiple graphics or topping modules can run cards with different graphics colors or topping foil in a single run, selecting the correct module for the job automatically — without stopping for operators to change supplies. Additional modules for embossing, laser engraving or smart card personalization can increase overall throughput

even more, especially if these processes are common bottlenecks. (The Datacard® Maxsys® card issuance system and the MX6000 system can do all of this without changing card setups.)

The MX6000 system, Maxsys system, the 9000 Series system and the Datacard® 7000 Series card issuance system all support the addition of multiple modules. However, the 9000 Series system requires setup changes while the MX6000 and Maxsys systems do not.

Job Consolidation

To process small jobs efficiently, systems need to be able to combine diverse card products in the same job. There are two ways to do this.

- **Job pooling.** This enables operators to select loaded jobs to be processed in a single production run without emptying the card track. If two jobs are pooled, the system runs the second job immediately after the first without requiring operators to clear and reload the system. The MX6000 system, for example, offers job pooling (at the system level) as long as the same job setup is used for both jobs. The 9000 Series and 7000 Series systems also provide job pooling, but it is done via FIR or at the host level.

- **Rainbow decks.** Rainbow decks are stacks of varied card stock loaded in the same input modules without separator cards. The different stocks are run as one large job instead of multiple smaller jobs, each of which would require a new setup. Rainbow decks can significantly increase efficiency by eliminating the setup and track fill time associated with each new card type. To successfully implement rainbow decks, the decks must be created manually. In most environments, this is done using separator cards that waste machine card track space.

Automatic Card Stock Verification

The use of rainbow decks often increases the need for quality checks to make sure the right card stock is used for every card. Additional quality assurance, however, can compromise efficiency as the number of card stocks rises and the number of cards per job drops down to 10, five or even a single card. Separator cards are not ideal, because they waste card track space.

To avoid an unacceptable increase in quality assurance, systems can automate card stock verification. In other words, the system has the ability to detect what card stock should be used for a particular job or record, as well as the ability to verify that the right stock is loaded for this job. This feature enables issuers to consolidate multiple small jobs with varying card stocks into one large job with confidence, without requiring new setups or emptying the card track. It is especially effective when combined with other small job processing features.

In the MX6000 system, automatic card stock verification can be achieved with a vision verification module. This module uses optical character reading technology to detect a card stock ID number printed on the card, then matches it to a corresponding card stock ID in the card record. If it is not practical to print card stock ID numbers on cards, the module allows users to match a specific pattern on the card to a pattern identified in the card setup. Either way, the data must be modified to include a card stock ID in each record or job. For card stock ID matching, an ID must be printed on each card. For pattern matching, a card stock setup must be created for each card type to identify the particular pattern.

Flexible Information Systems

Today's market dynamics require issuers to respond to customer needs with speed and flexibility. Intelligent information systems play an important role, because overall system versatility determines the variety of approaches issuers can use to meet a specific customer need. Here are two capabilities that flexible information systems usually offer:

- **Automated job optimization.** Orders for cards can come from many sources or from a single, consolidated computer system. In either case, the system presenting the orders is probably not able to organize the work to maximize production efficiency. Even if knowledge exists, order systems operate under rule schemes that were developed years ago, when the variety of card products was minimal.

  Manual job optimization is often done by a production supervisor, production scheduler or skilled operator. This person examines the orders and creates efficient jobs, using their knowledge of the orders received, the status and configuration of the production equipment and the required completion dates. Specifically, the person groups, splits or otherwise rearranges work to maximize efficiency during production. The level of efficiency gained depends entirely on the skills and knowledge of the person doing the optimization.

  Job optimization can also happen automatically. For example, the job automation module for Syntera software completes these tasks using the same information available to production supervisors. It automatically optimizes production schedules to minimize setup times, maximize productivity and utilize systems and labor effectively. By combining jobs in a way that minimizes setups, Syntera software can take 10 jobs of 10 cards each and make them function like a single 100-card job, significantly increasing efficiency and card output.

  Unlike manual job optimization, which relies on human review of information, automated small job processing relies on constraint programming, a cutting-edge technology for solving complex combinatorial problems. The constraint-based engine generates solutions reliably and efficiently, enabling users to compute one solution, several solution options, or the best solution to a given problem. Users need only provide product specifications, production equipment configurations and process specifications to take full advantage of automated, constraint-based schedule optimization.

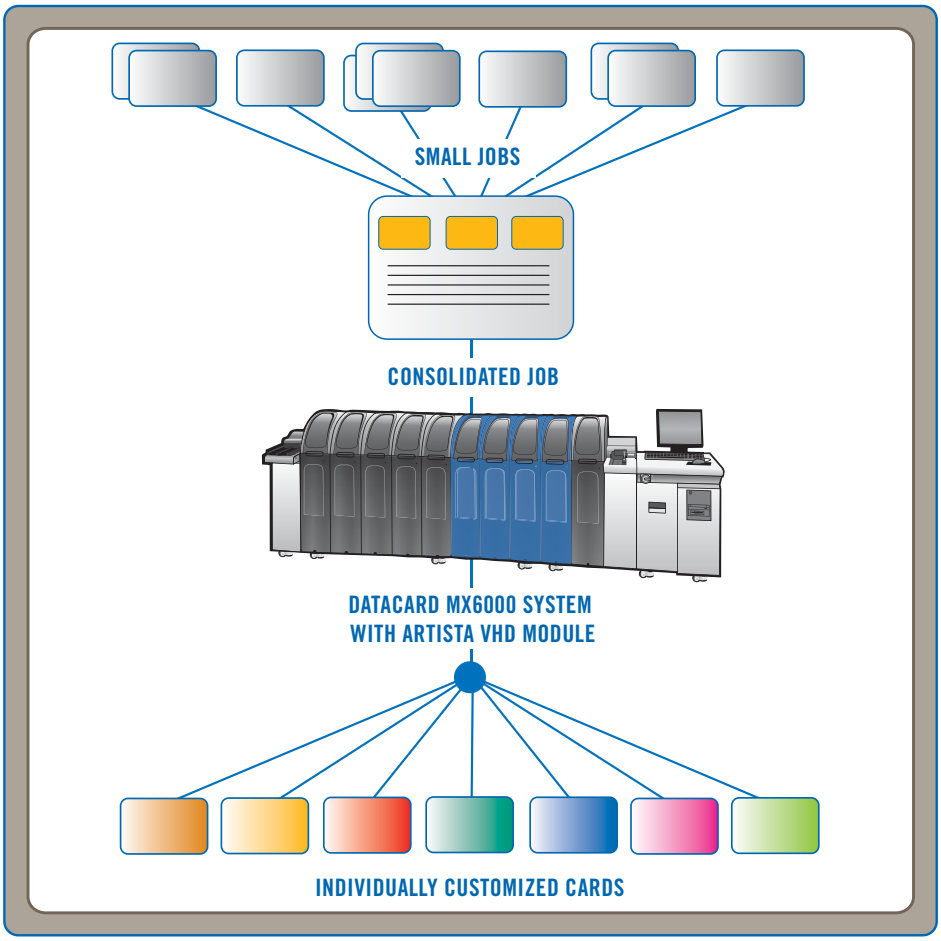
- **Remote job loading.** Systems with remote job loading enable users to load and delete jobs remotely, without operator involvement. The operator just hits the start button.

Print-On-Demand Technology

Mass customization requires an agile supply chain to function optimally. Speed and flexibility are critical. With the number of card types soaring and new products offered at an ever-increasing pace, accurately forecasting inventory is nearly impossible. Carrying large amounts of inventory of all card stocks is cost-prohibitive and difficult to manage. Plus, traditional offset printing incurs familiar problems when it comes to printing small batches of card types, which means issuers ordering in small quantities will pay more and wait longer.

So how can issuers provide customers with customized products on time, at a competitive price? The ultimate step toward mass customization is dynamic inline creation of various card stocks — eliminating preprinted inventory.

Printing card stocks on demand during the personalization process simplifies card stock inventory and purchasing. In fact, inventory management and purchasing can be handled by automatic resupply techniques. Inspection involves one or two types of cards, as opposed to hundreds or thousands. There is no longer any risk of having to throw out large quantities of discontinued or obsolete stock. Plus, the personalization process can reach efficiency levels that are comparable to mass customization. In other words, systems run very large jobs where each card is unique.



To date, only the Datacard® Artista® VHD retransfer color printing module for the MX6000 system offers this capability. This module prints edge-to-edge, 600 dpi color images using precise pigment ink retransfer technology. Inline full-color card printing allows issuers to produce different card stocks as needed during production, or print unique cards with comparable speed and efficiency to large batch printing. The benefits include lower card inventories, lower scrap charges, reduced setup time and reduced track fill time.

- **Digital asset management.** As the number of card products increases, so does the number of photos, images, logos, templates and other assets that must be managed in the production environment. With this explosion of assets, it becomes inefficient, impractical and error-prone to rely on a shared drives and manual asset management. To reduce complexity and eliminate waste, issuers should look for a solution that provides secure, consistent storage and processing for all digital assets.

  Datacard® Meritas™ digital asset management software provides a simple, intuitive approach to storing and managing all digital assets for the card production environment. It makes approved assets available to card issuance systems as needed. With its exceptional ease of use, Meritas software enables operators and others to benefit from more consistent process control and higher employee productivity.

- **Print-on-demand for fulfillment.** Organizations with a variety of fulfillment options will benefit immensely by printing forms and inserts inline, as they are needed. As with print-on-demand for cards, it allows issuers to eliminate stocking and managing a large inventory of preprinted forms and inserts. This not only reduces the risk of waste from obsolete forms — it further reduces variability and increases job size.

Step 5: Maximize the Value of Your Investment

Adding production hardware and software will create value without any additional effort on the part of card issuers. However, to fully realize the potential for improving efficiency, issuers must also make internal changes related to processes and data.

Process Changes

There are four process changes required to maximize efficiency. In general, all processes should be designed to maximize system productivity. As mentioned earlier, the biggest source of waste and inefficiency is when there are orders to fill and systems are sitting idle.

- **Maximize operator focus.** The most effective processes are designed so that the operator never leaves the system. Every time the operator leaves — to get cards, forms or inserts, to inspect cards, to create rainbow decks, or to move completed materials to the next process — the operator is not there to restart the system if it finishes its current job (or stops for any other reason). In addition, every time the operator leaves the system, he or she can be distracted by other tasks: resolving a problem with incoming cards, checking the status of a production chart or talking with other employees about the day's work. Ideally, the operator's role should be keeping the system running at all times. Pulling supplies, staging them for production, delivering supplies to the operator, inspecting supplies, counting cards and moving materials from the system to the next process should all occur upstream — not at the machine. These processes should be handled by material handling or quality control employees, not operators. To maximize system efficiency, maximize the operator's focus on the system.

- **Handle exceptions and error recovery effectively.** In many operations, the process works well for all standard jobs. But as soon as there are rejected cards, remakes, service issues or other unplanned events, the process becomes extremely inefficient. To avoid this, issuers should clearly identify how all exceptions are handled, including who is responsible for each task. For example, if there are damaged envelopes, it is up to material handling — not the system operator — to resolve the issue. Material handling should address the problem away from the system, allowing the operator to quickly move on and get the system running again. Issuers should also provide an effective way to get immediate service when operators identify a need, as well as clarify the operator's role during service.

- **Emphasize operator training.** The interaction between system and operator has a huge impact on efficiency. Great operators sense intuitively what the system is doing and they can address a problem at the back end before the front end has stopped running. Other operators hinder efficiency by restocking after the system has stopped, leaving the system for extended periods or incorrectly addressing a problem.

To maximize operator effectiveness, training must go beyond operation during smooth, exception-free production. Most inefficiencies associated with operator activity are caused by operators leaving the system unnecessarily or failing to diagnose problems. Operators should understand that the number one priority is keeping the machine running at all times. Operators must be well trained in error recovery to minimize downtime while errors are cleared and the system restarted. Although high-quality systems will prompt operators, untrained operators often waste time trying to figure out what these prompts mean. Some operators restart the system for every error, which is the most inefficient method of recovery.

Operators need to be able to quickly differentiate when they can resolve a problem and when a service technician is needed. Finally, operators must be trained on what to do when the service technician is working on the system (preparing materials for the next job, taking a 15-minute break, completing paperwork).

- **Streamline material flow.** A well-designed facility promotes efficient material handling, short transportation times and short queues. This helps drive work-in-process down, reduce inventory costs and improve production management. The most efficient facilities have a logical flow of materials through the shop, using one of two structures - both of which have delivered positive results in card personalization environments.

  The first structure is a work cell. In this model, the personalization, card delivery and inserting equipment are placed in a group, and one team is responsible for completing work on these systems from start to finish. With a work cell structure, material flow to and from the cell should be based on actual needs to optimize efficiency.

  The second structure is a linear flow. Systems and processes are arranged linearly throughout the facility as follows:

  The materials flow from the beginning of the line to end, and all employees understand the flow well.

Data Changes

Depending the approach chosen for automation (Dynamic Setup Method or Data-Driven Method), issuers may need to complete very few or very significant data changes to realize the benefits of mass customization. With Selection Criteria, no data changes may be necessary to automate job and card setup. If a field that can be used as the indicator for card setup does not currently exist, a field will need to be added. Otherwise, no data changes are required.

As a general rule, the more you control the behavior of personalization systems through embedded data, the higher efficiency you will achieve. The Data-Driven Method will require issuers to add elements at the record level for each item controlled, but this will reduce the number of card and job setup functions that must be performed. It will also minimize operator intervention and system stoppage.

Step 6: Track and Report Efficiency

Intelligent systems should provide dynamic information about the throughput of each system, and send alerts when stoppage occurs. Data analysis on track fill time, real-time efficiency calculations and on-screen reporting can be used to isolate problems, reduce disruptions and improve yields.

Real-time tracking and reporting can be implemented using the Datacard® Syntera® manufacturing efficiency software. Information about the job and cards can be fed back to a manufacturing execution system or broadcast on a production screen. Data that can be collected, tracked and reported include:

- Alerts on stopped systems
- Track fill time, production time, calculated efficiency rates
- Job and record status
- Card production counts
- Machine module list

SECTION 7. IMPORTANT INVESTMENT CONSIDERATIONS

Some systems are designed to support mass customization and some are not. The best solution is a combination of hardware and software specifically designed to maximize small job efficiency. Even if you are not yet moving toward mass customization techniques today, making an investment in systems that accommodate mass customization will save time and money in the long-term. Important investment considerations include the following:

- What features does the system use to improve small job efficiency?
- How many features can be controlled automatically via embedded data, rather than operator intervention?
- Does a supply change require system stoppage and track clearing?
- Can the system accommodate multiple modules to enable dynamic card attribute changes?
- How often will the system be stopped for setups, service and supply changes?
- What features does the system use to support job combination?
- What tools are available to automate and optimize job combination?
- Does the system verify card stock automatically?
- Can I add print-on-demand technology in the future to reduce inventory of card stock, forms and inserts?

SECTION 8. EXPECTED BENEFITS

The market dynamics that are moving card issuers toward mass customization are not likely to go away. Creating unique value for individual customers via mass customization is a natural progression occurring across many different markets, effectively replacing the mass production techniques that preceded them. Card bureaus and other card issuers that embrace the "markets of one" concept and begin adapting systems and processes for mass customization will not only survive, they will thrive and lead in a competitive market.

Here is an example of actual efficiency improvements made by employing some of the recommendations for Stage 3. Individual results will vary depending on the specific mix of products and systems, but the gains here are representative of the benefits issuers can expect.

	BEFORE	AFTER
TOTAL PROCESSING TIME	185.7	107.1
WEEKLY SETUP & TRACK FILL	133.7	55.2
% UNPRODUCTIVE TIME	72%	51%
MACHINES REQUIRED	11	6

Print-on-demand cards further increase efficiency, enabling issuers to create unique card products as orders are placed, without relying on preprinted inventory.

Benefits of this technology extend beyond efficiency as well. Consider the true cost of carrying inventory of hundreds — sometimes thousands — of different card stocks. Inventory levels rise as each individual stock is forecast to minimize stock-out conditions. The costs associated with higher inventory levels include: capital tied up in inventory and associated loss of interest on that capital; increased labor costs for material handling and inventory management; increased space and storage requirements; and increased scrap as card products are discontinued or changed.

It is important to maintain perspective on costs when evaluating the benefits of this technology. For example, on a per-card basis, print-on-demand cards are more expensive than cards that are preprinted and kept in inventory. Yet print-on-demand cards significantly lower the total cost of getting card products into customers' hands.

Production environments employing mass customization techniques can expect to realize all of the following benefits:

- Increased efficiency
- Reduced inventory costs
- Lower capital investment and depreciation
- Lower labor costs
- Shorter turnaround times
- Fewer stock-out situations
- Reduced scrap and waste
- Reduced obsolescence
- Lower space/facility needs
- Higher quality and reliability
- Improved flexibility in reacting to changes
- High labor efficiency and quality
- Fast market response

The bottom line: Issuers that take steps toward mass customization today can expect an immediate, positive impact on operational efficiency. To learn more about how you can realize these benefits in your production environment, please contact your local Datacard Group sales representative.

APPENDIX 1:

STAGE 1: MASS PRODUCTION	STAGE 2: MASS CHAOS	STAGE 3: CONTROLLED CHAOS	STAGE 4: MASS CUSTOMIZATION PHASE 1	STAGE 4: MASS CUSTOMIZATION PHASE 2
Few card and form types	Many card and form types	Many card and form types	Many card and form types	Many card and form types
Very large jobs	Small jobs	Medium jobs	Large jobs	Very large jobs
Traditional high-volume systems and solutions	Traditional high-volume systems and solutions	• Data-Driven or Dynamic Setup Method • Rainbow decks • Card stock verification • Automated job optimization or job pooling • Pause and change • Multiple modules • No machine setups • Process changes	• Data-driven production • Real-time inline digital card printing • Digital asset management • Pause and change • Multiple modules • No machine setups • Process changes	• All the capabilities of Phase 1 Mass Customization • Real-time inline form and insert printing
Fewest high-volume systems and operators	Many high-volume systems and operators	Fewer high-volume systems and operators	Few high-volume systems and operators	Fewest high-volume systems and operators
Lowest capital investment and depreciation	Highest capital investment and depreciation	High capital investment and depreciation	Low capital investment and depreciation	Lowest capital investment and depreciation
Highest labor efficiency and quality	Lowest labor efficiency and quality	Higher labor efficiency and quality	High labor efficiency and quality	Highest labor efficiency and quality
Simple inventory management	Highly complex inventory management	Highly complex inventory management	Cards: Simple inventory management Fulfillment: Complex inventory management	Simple inventory management
Low cost of incoming card stock	High cost of incoming card stock	High cost of incoming card stock	Lowest cost of incoming card stock	Lowest cost of incoming card stock
Few stock-out situations	Many stock-out situations	Fewer stock-out situations	Very few stock-out situations	Very few stock-out situations
Shortest turnaround time	Long turnaround time	Shorter turnaround time	Short turnaround time	Shortest turnaround time
Highest efficiency	Low efficiency	Medium efficiency	High efficiency	Highest efficiency
Lowest space/facility needs	Highest space/facility needs	Lower space/facility needs	Low space/facility needs	Lowest space/facility needs
Low scrap/waste	High scrap/waste	Some scrap/waste	Low scrap/waste	Lowest scrap/waste
Low flexibility for customers	Some flexibility for customers	Some flexibility for customers	High flexibility for customers	Highest flexibility for customers
Highest quality	Lowest quality	Higher quality	Highest quality	Highest quality

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