WHITE PAPER

Calculating ROI for the Formlabs Automation Ecosystem

The Formlabs Automation Ecosystem makes it easy to increase throughput without increasing your labor costs. The Form Auto, Fleet Control software, and High Volume Resin System work together with your team, reducing the need for printer interactions. The Automation Ecosystem has been deployed in different types of production environments — in this whitepaper, we'll walk through three manufacturing scenarios to explain cost per part and return on investment (ROI) calculations. These calculations are not one size fits all, and arriving at a personal and accurate ROI is completely dependent on the number of printers, labor costs, the type of parts, and many other factors. If, based on this report, you find that automation could be beneficial for your applications, our team will gladly help calculate the ROI for your own business.

March 2023

formlabs

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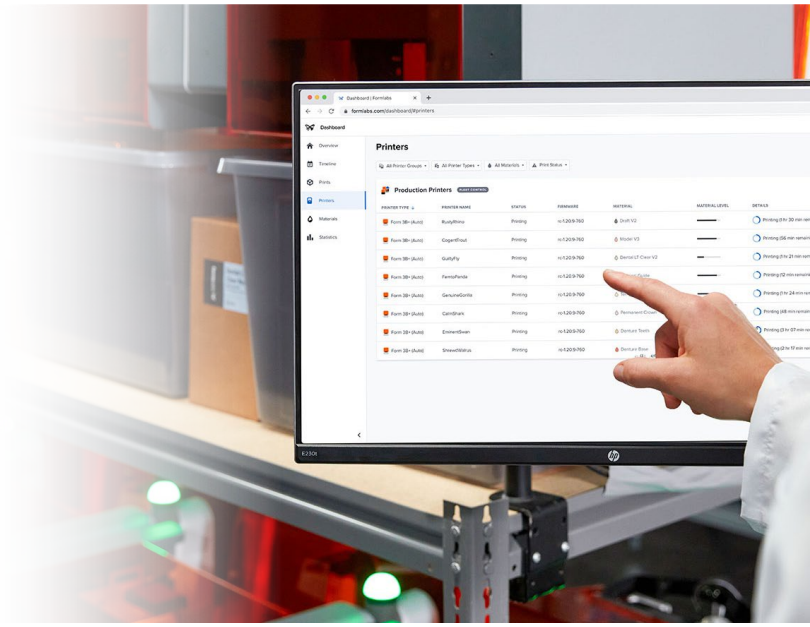
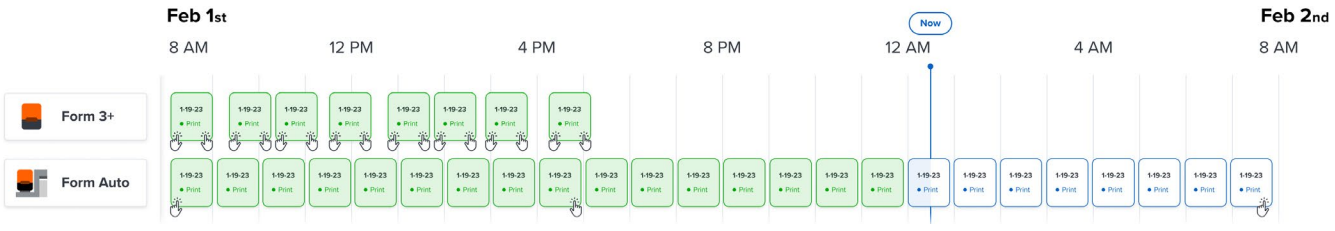
The Formlabs Automation Ecosystem

The Formlabs Automation Ecosystem consists of the Form Auto hardware attachment, Fleet Control suite of software features available in PreForm and Dashboard, and the High Volume Resin System. Together, these products work with any Form 3/3+ and Form 3B/3B+ printer to automatically remove parts after printing, start new prints directly from the queue, and reduce the number of touches to minimize labor tasks.



By utilizing the Quick Release Technology of Build Platform 2, Form Auto makes it possible to eliminate the need for an operator between print jobs. Though interactions like removing parts or changing resin cartridges typically only take a few minutes, they make it necessary for an operator to be physically present multiple times during the day, and plan their schedules accordingly. Form Auto allows operators to spend their time on more high-value tasks without disrupting their regular workflows. Batch post-processing can be accomplished quickly and easily when multiple rounds of print jobs are completed – further consolidating the workflow so that operators can oversee higher volumes of fully finished prints.



The value of the Automation Ecosystem lies in this increased throughput and reduced labor, making it easy to scale up production with fewer printers and without additional labor. If increasing volume is not the main goal, the Automation Ecosystem can still provide value by reducing the need for multiple shifts of operators, or by allowing them to spend time on other higher added-value tasks.

VALIDATING YOUR WORKFLOW AND APPLICATIONS FOR FORM AUTO

When considering if automation makes sense for your 3D printing workflow, it's important to consider a few key features. Form Auto does have some limitations:

- Softer durometer materials such as Flexible Resin and Elastic Resin aren't suitable for the Quick Release Technology of Build Platform 2, and thus aren't an option for Form Auto.
- Individual parts have a height limit of 110 mm, to allow room for Build Platform 2 to bend and extend, without pushing the parts into the bottom of the basket.

The most advantageous scenario for implementing the Formlabs Automation Ecosystem is high volumes of similar parts in the same material. High volume workflows like these are commonly found in dental labs, internal or external service bureaus, and mass customization production.

Return on Investment: How to Calculate Costs for the Formlabs Automation Ecosystem

Having one precise calculation for return on investment (ROI) that can represent any situation is difficult. Variables such as part geometry, type of material, consistency of part demand, and cost of labor all change from business case to business case.

Formlabs' calculations for utilizing the Automation Ecosystem in our own production facility concluded that increasing the volume of parts did not require a commensurate increase in labor, thus the 80% labor savings cost reported.

While reducing costs and increasing productivity at this rate are completely attainable goals, every business should conduct their own return on investment calculation before integrating the Automation Ecosystem into their workflow. Individual calculations can be done with the help of the Formlabs team, but we'll also provide a framework for them here, using several different examples.

THREE ITEMS TO CONSIDER

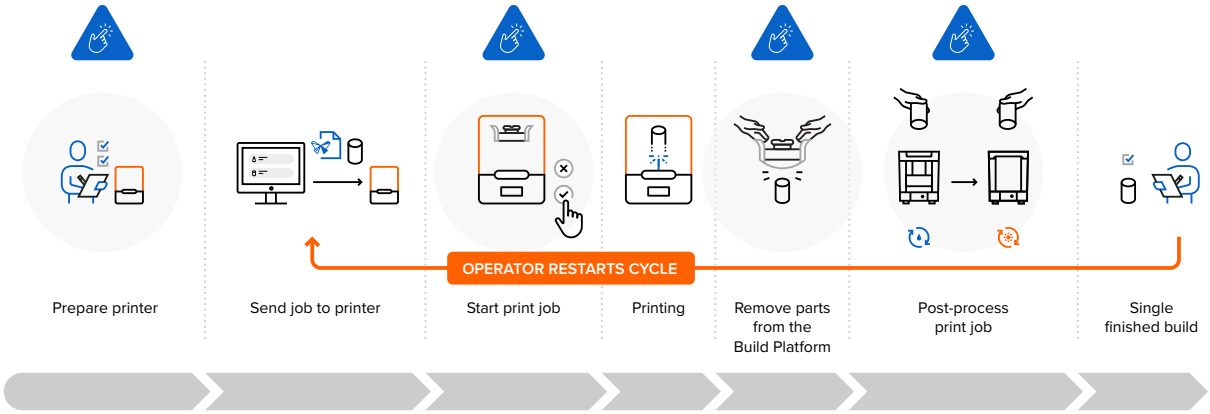
Calculating cost per part for 3D printed parts requires accounting for the costs of equipment ownership (depreciation), material, and labor.

The material costs per build stay the same both with and without Form Auto, because the number of parts (or resin volume) per build doesn't change when adding automation, only the number of builds possible each day.

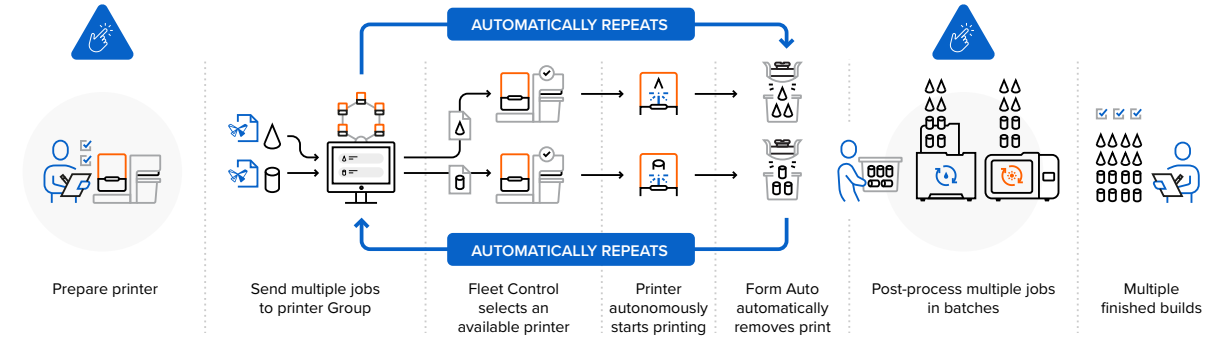
For depreciation, we took the cost of the equipment divided by the number of parts printed over a three year period. Each year period is assumed to include 250 days of labor — or a typical Monday-Friday work schedule, accounting for vacation, bank holidays, and sick leave.

Labor costs are the most important, and most variable, part of this equation. Our assumptions include a $50/hour labor cost for the employer, and that these labor time savings can be extrapolated out for a multi-printer set-up. Labor savings will make the most difference in a production environment, where the addition of the Form Auto can streamline production to such an extent that all printing interactions can be grouped into small slots of time at the beginning of each day.

Formlabs SLA 3D Printing Workflow



Form Auto with Fleet Control



EXPLAINING TOUCHPOINTS AND LABOR TIME

For most manufacturing processes, including with 3D printing, labor is the largest contributor to overhead, and thus cost per part. The following tasks typically take two minutes each to complete, but are completely automated with the Form Auto.

- Removing Build Platform from printer
- Taking parts off Build Platform
- Re-inserting Build Platform into printer

Operating Form Auto still does require the operator to perform a few tasks, which are the following:

- Two minutes to move a bucket of parts into and out of Form Wash or Form Wash L/
- Two minutes to move washed parts from Form Wash to Form Cure or Form Wash L to Form Cure L.

These tasks, however, are performed only once a day, as multiple builds are batched together in the bucket and can be moved, washed, and cured all together. Without Form Auto, these tasks would be performed after each print. With Form Auto, these tasks are performed only once a day, but still only take two minutes. Replacing the Form Wash L IPA is a 30 minute task, but it should only be performed every 326 builds. Though this has been factored into labor cost for operations both with and without Form Auto, over the course of so many builds, it has a negligible impact on overall labor time.

Case Studies

Mass-Customized Consumer Products

Slightly different files, high volume, one operator

At this large consumer goods manufacturer, a new product line offers mass customization options for toys. Customers scan their face and receive a toy with personalized features, clothes, and accessories. Traditional methods of manufacturing are prohibitively expensive due to the cost of tooling for each customized item. 3D printing easily produces many toys without expensive tooling, but at the high volume of prints, requires many operator interactions to manage the print farm. These parts are ideal for Form Auto processes due to their small size, similar file geometry, and low height.

	Without Form Auto	**Form Auto** (Printers active 24 hours a day)
Equipment	• Form 3+ Basic Package • 1 year Pro Service Plan • Build Platform 2 • 2 x Form Wash	• Form 3+ Basic Package • 1 year Pro Service Plan • Form Auto • Build Platform 2 • 2 x Form Wash L

Productivity	50 (2 builds per day) (printers active 8 hours a day)	125 (5 builds per day) (printers active 24 hours a day)
Operator interactions	2	1
Total minutes of labor per build	10.4	1.6
Labor cost per build	$8.86	$1.57
Material cost Per Build	$12.15	$12.15
Depreciation Per Build	$3.05	$3.26
Total Cost Per Build	$24.06	$16.98
Total Cost Per Part	**$0.96**	**$0.68**

Small, almost identical parts like these toy heads represent an emerging business case for mass customization. Form Auto enables more opportunities for profitably manufacturing customized products by decreasing the cost per part.

The increase in productivity (125 parts/day vs. 50 parts/day) and lower labor costs get the cost of end-use 3D printed parts closer to injection molding and traditional manufacturing methods, while avoiding any expensive tooling costs for customized products.

To achieve this increase in productivity without the Form Auto, the company would have to purchase at least two more printers, or add two more shifts of labor. A Form 3+ package including Form Auto costs less than the two and a half Form 3+ printers capable of the equivalent throughput, so purchasing one Automation Ecosystem is cheaper than purchasing multiple machines, avoids adding extra labor costs, and frees up your existing labor force to do higher-value tasks. Because they're only interacting with the parts once, in one single batch, employees can spend the rest of the day accomplishing other tasks. Reducing the number of tasks also makes the integration into an existing workflow much smoother and easier to learn.

Dental Lab

Slightly different files, high volume, one operator

Dental labs producing a large number of customized parts for a small range of applications are the ultimate fit for 3D printing and automation. We'll use the example of 3D printing full arches for thermoforming clear aligners, which is one of the most common applications, but Form Auto is also ideal for producing restorative models, splints, surgical guides, and other high volume dental applications.

	Without Form Auto	**Form Auto** (Printers active 24 hours a day)
Equipment	• Form 3B+ • 1 year Dental Service Plan • Build Platform 2 • 2 x Form Wash	• Form 3B+ Basic Package • 1 year Dental Service Plan • Form Auto • Build Platform 2 • 2 x Form Wash L
Productivity	64 parts - 8 builds per day (printers active 8 hours a day)	176 parts - 22 builds per day (printers active 24 hours a day)
Operator interactions	8	1

Total minutes of labor per build	12.8	2.6
Labor cost per build	$10.91	$1.62
Material cost Per Build	$17.18	$17.18
Depreciation Per Build	$1.46	$1.09
Total Cost Per Build	$29.55	$19.89
Total Cost Per Part	**$3.69**	**$2.49**

The combined output of the Form Auto and the Form 3B+ is 175% higher than that of a single Form 3B+, which means the lab would have to buy almost three Form 3B+ printers to achieve the same output. As the price of the Form Auto is less than the price of a Form 3B+ unit, this means that the investment is net ROI positive right from the start.

Looking at the cost per part, the biggest part savings comes from labor costs. Without automation, producing arches on the Form 3B+ requires a technician to interact with the printer for more than one hour total throughout the day, disrupting their regular workflow eight times. They'd have to monitor the printer for much of their day, having just one hour to accomplish other work before having to return to the printer for small tasks. At an assumed $50 hourly labor rate, automation can save more than $1 in labor costs for each part, or more than $50,000 in a single year. Even an hourly labor rate below the minimum wage in all US states or practically anywhere in the EU will still result in labor savings — and that's not considering the savings due to fewer disruptions in the workflow.

Given the large throughput of both solutions, depreciation is practically negligible in the cost per part equation. Thanks to the higher overall productivity and lower costs, however, the Form 3B+ and Form Auto bundle comes out lower.

For any medium to high volume dental lab that has enough demand to justify running two 3D printers, automation is the superior solution. They can operate fewer or shorter shifts, increase productivity and let their precious human resources focus on other higher added value work. For high volume dental labs running even larger fleets of 3D printers, these benefits can be extrapolated at scale. If the lab operates ten printers, the labor time saved amounts to multiple full days.

Rapid Prototyping Lab at a Hardware Company

Very different files, medium volume, multiple operators, overnight printing sometimes possible

In this rapid prototyping lab, several operators have access to two 3D printers, and during their product development sprints, need to use the printers continuously. The main materials used are Grey Resin and Durable Resin for form and fit prototypes. Material choice is important — having to switch materials between every print job would negate the benefits of the Form Auto as it wouldn't be able to run continuously.

A major blocker to productivity in this lab is the management of the print queue — with multiple users jostling for position on the printers, sometimes prints aren't sent to the most efficient destination, and a printer might sit idle overnight when it could have turned out multiple users' files before morning.

Though between sprints these printers might sit idle for up to a week, it is vital that there are no bottlenecks during the rapid iteration phase. Waiting for a print to finish in order to perform tests and gather feedback slows down the product development process. For the following example we set the yearly usage at 80 days in an effort to reflect this sporadically intensive printing schedule.

Adding a Form Auto allows parts to be printed continuously, including overnight and on the weekends, systematically working through the print queue and getting multiple designers' work ready for post-processing each morning.

	Without Form Auto (printers active 8 hours a day)	**Form Auto** (Printers active 24 hours a day)
Equipment	• Form 3+ Basic Package • 1 year Pro Service Plan • Build Platform 2 • 2 x Form Wash	• Form 3+ Basic Package • 1 year Pro Service Plan • Form Auto • Build Platform 2 • 2 x Form Wash
Productivity	24 - 2 builds possible (printers active 8 hours a day)	36 - 3 builds per day (printers active 24 hours a day)
Total minutes of labor per build	12.8	4.1
Labor cost per build	$10.95	$3.94
Material cost Per Build	$21.47	$21.47
Depreciation per Build	$9.54	$15.29
Total Cost Per Build	$41.96	$39.28
Total Cost Per Part	**$3.50**	**$3.27**

Gear Assembly
(Durable Resin)

	Without Form Auto	**Form Auto** (Printers active 24 hours a day)
Equipment	• Form 3+ Basic Package • 1 year Pro Service Plan • Build Platform 2 • 2 x Form Wash	• Form 3+ Basic Package • 1 year Pro Service Plan • Form Auto • Build Platform 2 • 2 x Form Wash
Productivity	12 - 2 builds per day (printers active 8 hours a day)	36 - 6 builds per day (printers active 24 hours a day)
Total minutes of labor per build	12.8	2.6
Labor cost per build	$10.88	$2.52
Material cost Per Build	$14.17	$14.17
Depreciation per Build	$6.36	$8.73
Total Cost Per Build	$31.41	$24.72
Total Cost Per Part	**$5.23**	**$4.12**

In an internal service bureau situation like this, multiple users can complicate printing processes. There will be instances of one department needing prioritization over another, or crossover when multiple people are trying to use the printers at once. If one person is removing their part, and another is waiting to re-insert the build platform to start their own print, the whole process becomes less efficient and takes much longer.

The Formlabs Automation Ecosystem removes that complexity. Fleet Control offers a centralized queue where multiple users can add, duplicate and prioritize prints at any time across a fleet of 3D printers; the software then automatically assigns a printer for the print based on common consumables. Form Auto increases productivity and makes it possible to complete multiple builds overnight.

Form Auto makes it easier for many different people and teams to use the printers, without having to bring in additional units for just their department. Internal service bureaus become more productive and more efficient, allowing each team to complete their projects in record time. The Automation Ecosystem also helps avoid the siloing that happens when teams only use their own equipment. Having machines in one location, printing all the time simplifies and streamlines operations for material, labor, and space management.

The Impact of Lower Cost Per Part and 24/7 Printing

These examples are illustrative of both the increased output made possible by the Automation Ecosystem as well as the reduced cost per part. Labor is a primary factor in overhead spend for the vast majority of companies. Many businesses, especially those reliant on hourly employees, do their utmost to avoid any overtime wages. The Automation Ecosystem can help reduce the number of daily tasks needed to operate 3D printers, and avoid any overtime.

This lower cost per part also opens up new opportunities for mass customization as it brings the cost per part closer to that of injection molded or traditionally manufactured plastics. By increasing the throughput possible in a 24-hour period, the Automation Ecosystem enables small businesses to compete with larger companies able to invest in traditional mass manufacturing, speed up their time to market, and establish secure means of in-house, stabilized production. For large businesses, the Automation Ecosystem can streamline operations, and take some of the complexity out of multi-printer fleet management. When many users have access to centralized printing locations, Form Auto and Fleet Control can reduce miscommunication and eliminate bottlenecks by printing through the night.

Applying the Framework to Your Own Workflow

The examples above have a set of assumptions, such as the labor cost per hour, or number of Form Wash L machines available. But setting up a similar workflow is simple, and with a few tweaks, this algorithm can be applied to the 3D printing workflow at any company.

Considering the formula with specific inputs from your own file data in PreForm, labor costs, machines available, and time constraints is imperative. Contact our team to understand if 3D printing automation is the right fit for your business and to get a report with the estimated reduction in cost per part as well as the increase in throughput based on your own inputs.

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