



CASE STUDY: REVOLUTIONIZING AUTONOMY IN AGRICULTURE THROUGH STRATEGIC PARTNERSHIPS

INTRODUCTION

The agricultural sector, including Original Equipment Manufacturers (OEMs), constantly seeks innovative solutions to enhance productivity, sustainability, and profitability through more consistent, higher-quality labor. Finding solutions often leads to strategic partnerships between OEMs and cutting-edge autonomy businesses. After meeting in 2016 through a leading Lidar solutions provider, Mach, a key provider of agricultural technology solutions, and GUSS Automation Group, a pioneer in autonomous farming machinery, joined forces. The goal for the partnership was a challenging one to tackle, but together Mach and GUSS set out to revolutionize off-road autonomy to solve issues related to labor and quality in the specialty crop field.

The outcome of this partnership resulted in autonomous vehicles for orchards and vineyards that enhance productivity and profitability by being able to operate in GNSS-challenged areas.

COMPANY BACKGROUNDS

Mach Overview

Mach has established itself as a leader in the agricultural technology sector, offering innovative solutions designed to optimize farm operations. Mach provides the most advanced and commercially proven off-road autonomy solutions in the industry. Their mission is to empower leading OEMs by providing world-class, dynamic solutions in perception, navigation, route planning, monitoring, and connectivity. Mach's suite of products includes perception sensors, vehicle automation equipment, data analytics platforms, remote sensing technologies, and farm management software, all aimed at enabling smarter, data-driven decisions.

GUSS Automation Overview

GUSS Automation stands at the forefront of agricultural automation and uses proven, dependable parts that growers know and trust. GUSS, the Global Unmanned Spray System, leverages decades of experience in the spraying business, allowing them to choose only the best componentry for their machines. GUSS was launched to respond to growing challenges for labor, efficiency, precision, and safety and provides autonomous spraying solutions for growers.

THE CHALLENGE: A NEED FOR AUTONOMY IN A CHALLENGING ENVIRONMENT

The world of autonomy is changing the agriculture industry, and being the first to introduce a specific autonomous solution was a vital first step for moving the industry forward. As the autonomous space started to develop within agriculture, Mach recognized a need to provide emerging OEMs with solutions to drive autonomy forward. One common challenge faced by many OEMs serving agriculture can be finding a solution that can navigate in GNSS-challenged environments, increase worker safety, and precisely traverse tightly constrained areas.

A PARTNERSHIP FOR SUCCESS

Partnership Formation

In 2016, GUSS Automation, then known as Crinklaw Farm Services (CFS), recognized a need for autonomous sprayer technology that could support permanent crops such as orchards and vineyards. As the first OEM to go after this market, their challenge was to find a partner who could provide them with the hardware and software solutions to autonomously navigate and spray orchards and vineyards where GNSS coverage is often limited due to the overhead tree canopy.

"We needed an autonomy partner that understood and supported autonomy in GNSS limited or denied areas such as orchards," says Chase Schapansky, Chief Technology Officer at GUSS Automation. "In these environments there is a lot of vegetation, trees, and other conditions that cause GNSS signals to be lost, making autonomy hard to implement."

Working to launch their autonomous sprayer, GUSS Automation prioritized finding the right partner to help them on their mission to provide this solution to permanent crop growers. After working with another robotics company for over a year with little traction, they needed a new partner to help overcome degraded GNSS performance under the orchard canopy and operate within tight and often cluttered tree rows.

At the time, back in 2016, both GUSS Automation and Mach were working with a mutual partner who recognized the struggles GUSS was experiencing. After a call went out for help through the partner's network to see who could take the Lidar sensor and make it work for their application, Mach responded to that request, and the two companies were put in contact to begin discussions and testing.

"We met with what was then Crinklaw Farm Services (CFS) back in 2016, now of course known as GUSS. Through our conversations, we were able to understand and identify the specific solutions they were looking to develop - an autonomous sprayer for permanent orchard crops. They had been looking for an autonomy company that could provide a solution in GNSS-denied or degraded areas," explains Colin Hurd, Mach CEO. "They shared their Lidar data, which we analyzed with our Lidar processing framework and produced a video depicting the detection and tracking of trees within an orchard row. CFS was impressed by the video and asked for a proposal."

Before the partnership was solidified, the two teams spent time discussing the specific parameters of what GUSS wanted to accomplish. Driven by customer feedback, GUSS was looking at the time to focus on a few important features to enhance their offerings including drive-by-wire interface, operations the vehicle could perform, a user interface for the grower to interact with the vehicle, and more. After ensuring these requests were on the table and they had a path forward to accomplish these goals, the two teams were ready to move forward with the partnership.

OBJECTIVES

The partnership was driven by three key objectives:

- 1.** Operate autonomously and navigate in GNSS-challenged environments (i.e. under thick tree canopies)
- 2.** Create a farmer-friendly interface - useable and intuitive
- 3.** Build a better electronic enclosure that was inexpensive, easy to produce, and ruggedized for the environment it would be working in

INTEGRATION OF DATA AND AUTOMATION

After Mach and GUSS Automation agreed on a proposal and path forward, the initial phase of the project began. GUSS shared their vehicle and drive-by-wire specifications, which Mach used to develop a vehicle-specific interface for their off-road autonomy software stack.

The first major milestone for GUSS and Mach was to perform rigorous integration testing at GUSS's headquarters in California, before the vehicle was ready for limited operational tests.

"Then it was off to California to test-drive the vehicle," says Jim Hollinger, Mach Director of Software Engineering. "Basic vehicle driving and control was verified in short order as well as maneuvering within orchard rows. However, challenges such as perfecting end-of-row turns and minimizing steering and speed fluctuations while spraying, necessitated follow-up trips. GUSS supported the integration effort by continuing to test between trips and providing critical feedback."

In addition to testing and data collection, the two companies had to develop interfaces and protocols for seamless communication. This integration enabled real-time adjustments in spraying operations based on accurate, immediate data.

Through many trips to the Golden State, Mach established a robust testing and data collection mechanism to allow the GUSS team to operate more seamlessly and share consistent information and data back to Mach for analysis.

As those who operate in agriculture know, conditions may not always present the best opportunity for collecting consistent, reliable data. For GUSS, not only were they dealing with potential customers who may have connectivity issues, but the more pressing challenge was the crops their customers grew presented cluttered environments as orchards and vineyards often have large obtrusive foliage. After a year of continued improvements and testing, beta testing began with GUSS customers.

"After several years of refinement, we delivered the first units to customers in late 2019 and we officially became GUSS Automation, LLC, an individual business to sell an autonomous orchard sprayer to customers," Schapansky of GUSS Automation explains.

KEY MILESTONES IN THE PARTNERSHIP

Throughout the partnership, there were seven major milestones of the project.

Initial Development Phase

Vehicle Development:

The vehicle needed to operate in areas with very little margin due to trees on both sides and limited space at the end of the rows for turning around. This stage involved intensive engineering efforts to develop the vehicle's navigation and obstacle avoidance systems.

Refinement of Driving Capabilities

Iterative Testing:

In close collaboration with GUSS in California, Mach engineers worked to refine the vehicle's driving capabilities to ensure it navigated in orchards and vineyards while in GNSS-challenged conditions, without colliding with trees or other obstacles. Several rounds of in-person testing and adjustments were conducted to enhance the vehicle's performance.

User Interface Development

Interface Optimization:

While vehicle tuning and iterative testing were performed, Mach also dedicated efforts toward creating a user-friendly and intuitive interface for mapping orchards, planning routes, and controlling and monitoring the autonomous vehicle. Leveraging Mach's expertise and background in the defense space, they were able to leverage their existing DOD vehicle interface to customize and refine the technology to meet GUSS's specific requirements, enabling efficient setup and operation, and providing the capability for one person to remotely operate up to 8 vehicles.

Evolution of GUSS as a Company

Company Formation:

Originally a project under Crinklaw Farm Services (CFS), GUSS evolved into a separate entity recognizing the potential demand for autonomous farming solutions at scale. Throughout this time, the partnership played a pivotal role in this transition, providing the technological foundation for GUSS to establish itself as an independent company.

Commercialization and Expansion

Product Launch and Recognition:

In 2018, GUSS made its debut at the World Ag Expo, showcasing its autonomous spraying system powered by Mach's technology. Entering into the new products competition, the company won the "Top 10 New Products" Award, making its mark in the industry. The positive reception led to GUSS's official introduction to the market, attracting worldwide attention from potential customers and stakeholders.

Production Scale-Up:

Following successful demonstrations and feedback, GUSS entered into a production supply agreement with Mach in 2019, marking a significant milestone in its commercialization journey. This agreement enabled GUSS to scale up production and offer its autonomous systems to a broader customer base.

Endless Possibilities:

While the technologically sophisticated vehicle created from the partnership of GUSS and Mach was the very first autonomous sprayer to go to market, it opened up the doors for other companies to follow suit. It paved the way for many other applications to adopt autonomous technologies in agriculture.

Industry Recognition and Partnerships

Innovation Awards:

GUSS's innovative autonomous technology received industry recognition, including an innovation award at CES in 2020, further solidifying its position as a leader in agricultural automation.

Partnership with Deere & Company:

In 2022, GUSS formed a partnership with Deere & Company, a major player in the agricultural machinery industry. This partnership aimed to leverage Deere's resources and distribution network to accelerate GUSS's growth and market penetration. It also recognized the commercial potential for autonomous solutions in the agriculture sector.

Continued Support and Evolution

Legacy Support:

Despite changes in partnerships and ownership, Mach remains committed to supporting the 250+ GUSS vehicles that utilize its hardware and software. This ongoing support ensures continuity for existing customers and demonstrates Mach's dedication to customer satisfaction.

HOW WE DEVELOPED OUR PARTNERSHIP PROJECT



OUTCOMES AND IMPACT

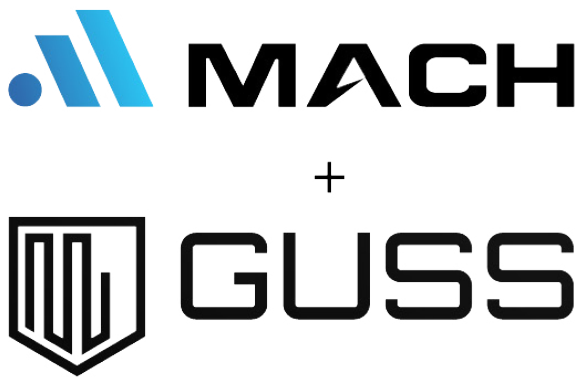
Increased Crop Yield and Quality: The integrated solutions led to more precise farming practices, resulting in higher quality and quantity of produce.

Reduced Operational Costs: The efficiency of autonomous machinery combined with data-driven insights reduced waste and operational expenses by 35%.

Enhanced Environmental Sustainability: The targeted application of resources and reduction in chemical inputs contributed to more sustainable farming practices.

Scalability Across Various Farm Sizes: The success of the pilot programs demonstrated the potential for scaling the technology across different farm sizes and configurations.

Minimized Dependency on Labor: The overall efficiency (less labor, fewer chemicals, more accurate spraying, etc.) has reduced the amount of labor needed.



CONCLUSION

Two industry leaders, GUSS Automation and Mach, combined forces to deploy the first self-propelled sprayer in the orchard market. After 8 years, 2 million acres covered and 250 sprayers launched commercially, this new autonomous solution has a wide footprint in the agriculture industry and has garnered the attention of widely recognized companies. Its ability to operate autonomously within the tight constraints of a cluttered orchard with a thick overhead canopy is revolutionary.

"We were highly motivated to make autonomy work, and because we understood the technology, GUSS and Mach were able to collaborate in all phases of the project," says Schapansky of GUSS Automation.

"Together we helped change the ag industry by introducing an effective solution to orchard crop spraying, paving the way for more innovative autonomous technology," Hurd notes. "The collaboration during development and testing allowed for a more effective process, reducing cost and time."

In addition, partnerships like those between Mach and GUSS Automation are vital as a strategic response to specific industry challenges. The approach of collaborating directly with the OEM from the beginning is something both companies recognize helped the partnership and product development go a long way.

"Mach is looking forward to future OEM partnerships and building solid relationships to produce not only what they are looking for, but provide a great product that is successful for everyone," Hurd says.

Jim Hollinger, Mach Director of Software Engineering agreed. "GUSS was a true hands-on partner which made for a successful partnership from the very beginning."

"Utilizing the knowledge and experience from both companies allowed us to create autonomous vehicles for orchards and vineyards that increase productivity and profitability by being able to operate in GNSS-limited areas," Schapansky of GUSS echoed.



INNOVATION. PARTNERSHIP. SUCCESS.

