



Increasing Net Efficiency with Next Generation Modular Factories (NGMF) and Green Initiative Integration

White Paper



NGMF

NEXT-GENERATION MODULAR FACTORY

— POWERED BY **GHOLDRAM** —

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The Global Manufacturing Bottleneck

Supply chains around the world are struggling to keep pace with market demand — from raw materials to finished products — and factories producing mission-critical components are facing compounding losses in materials procurement and workforce staffing.

Most regions are also dealing with ageing electrical infrastructure, inadequate transportation networks, ever-increasing population needs, and lacklustre regulation around pollution control and RoHS (Restriction of Hazardous Substances) compliance.

The current global and geopolitical climate has triggered an unprecedented chain of disruptions across every major manufacturing field. While COVID-19 and the crypto boom set the first dominoes in motion, the three biggest contributors to today's "Great Bottleneck" are: the AI integration surge; the conflicts in the Middle East and the volatility associated with the closure of the Strait of Hormuz; and processor and ASIC shortages, amplified by AI-driven demand for SDRAM and GPU/NPU-hungry, gigawatt-class data centres. Compounding the issue further, the majority of production infrastructure for these silicon chips is located in geopolitically unstable regions such as Taiwan and mainland China.

In short: there are not enough roads, machinery, staffing, electrical and water infrastructure, processors, and ASIC chips — nor enough raw material throughput — to close these gaps at the pace demand is growing. The priority, then, is to increase production and delivery efficiency to maximise utilisation of existing pipelines, while infrastructure improvement programmes pave the way for future manufacturing capacity.

Introducing Next Generation Modular Factories (NGMF)

NGMF is a scalable, high-efficiency architecture designed from the ground up to be environmentally compliant — meeting EPA, CEPA, and equivalent international environmental standards — fully interconnected, easily maintainable, and highly secure, with as little human intervention as possible. Its fully dynamic and adaptable design is malleable to any manufacturing environment, with major market penetration points including, but not limited to:

- Mining, processing, and/or recycling of precious metals
- Manufacturing of polyethylene terephthalate (PET) and other plastics
- IC and ASIC foundries operating at the 40nm manufacturing node or above, to produce domestic RISC-V microchips
- High-fidelity lens manufacturing and CNC diamond turning, including vanadium oxide (VOx) microbolometer thermal imaging technology

- Composite weaving (Kevlar and carbon fibre) and high-precision CNC volume manufacturing

Current Development Stage

It's worth noting where each component of this vision currently stands. The underlying control architecture powering FMP was developed and proven within Gholdram's defence R&D division, where it manages systems requiring ITAR-grade security and reliability. The civilian manufacturing adaptation of that platform — FMP itself — has been built out and demonstrated in a working prototype, examples of which are shown later in this document. The NGMF hardware architecture, by contrast, remains at the conceptual and early engineering stage (TRL 3–4): defined in detail, but not yet deployed at a pilot facility. We are actively seeking partners and pilot opportunities to take NGMF from architecture to operating reality.

Methods Used to Increase Production Efficiencies within NGMF

We must take advantage of AI automation to the highest degree in order to maximise production volume and minimise downtime per machine/station. Every production line must be fully automated from the input to the output side, powered by automated forklifts and carrier pods/conveyor belts. By integrating sensory and precision control systems into existing and new manufacturing processes such as centrifuges and mixers, mills and lathes, we gain per-machine fine-tuning and tighter control tolerances through continuous monitoring of each line's operating parameters.

Examples of net gained efficiencies:

- Reduction in wasted precious materials, both new stock & recycled
- Less wear & tear on tooling & drivetrains
- Subsequently reduced downtime due to tool changes & maintenance
- Faster throughput & reload times per station
- Higher batch consistency & lower quality-control rejects
- Reduced process-to-process buffer & lag time
- Compact NGMF architecture allows higher-density production lines per square foot
- Contactless production lines without putting personnel at risk
- Reduced personnel overhead due to extensive automation

Methods Used to Increase Power Factor (PF) and Carbon Footprint Efficiencies

- Decreasing wasted energy and material stock is a key design philosophy that NGMF utilises to increase net cost efficiency. Current axial flux and switched reluctance motor

(SRM) designs, paired with high-efficiency, closed-loop control electrical systems, are capable of electromechanical efficiencies of up to 98% under ideal operating conditions — figures NGMF's drivetrain architecture is engineered to take full advantage of throughout its electrical and mechanical systems. These motor types are also significantly more compact than traditional designs, capable of reducing mounting space requirements by up to 45% per pound-foot of torque (lb-ft) — a space saving NGMF's high-density production lines are designed to capitalise on.

- Power delivery is also a monumental challenge when managing high-density manufacturing lines, particularly regarding multiplexed control systems, high inrush current demands, and nominal operating temperature ranges.
- Voltage sag, brownouts, and thermal overload cause extreme stress on all electrical and mechanical systems operating within the facility, leading to premature wear and tear on equipment. This not only decreases the PF of the facility, but also dramatically increases downtime due to equipment failure and lengthy maintenance schedules.
- NGMF addresses these challenges through high-voltage direct current (HVDC) power distribution, using a strict DC-to-DC-only conversion approach to maintain near-ideal load balancing for the high-frequency switch-mode power supplies (HF-SMPS).

Workforce Impact on Retrofitted and New Facilities Integrated with NGMF

The most obvious benefit of the NGMF architecture, in terms of workforce-related costs, is reduced personnel requirements and human intervention within automated processes. Fewer people working on the production floor means decreased payroll, decreased HR costs and training downtime, lower PPE and lodging requirements, and — most importantly — fewer hazards for personnel to manage.

The following points outline more nuanced advantages of reduced personnel workload and deeper automation integration:

- Reduced brain drain and loss of institutional knowledge
- Industry best practices preserved and archived indefinitely
- Lower-cost HVAC and on-site comfort requirements
- No disruption to the production line due to short-staffing or acts of God
- Decoupled from local and geopolitical conditions that cause staffing disruptions
- Reduced exposure to labour disputes and scheduling constraints
- No requirement for staff breaks, shift rotations, or rest periods
- Equipment is replaceable and covered by warranty support
- NGMF scales according to available real estate, with no upper limit on facility size
- Complete operational control over the production line, with no need for hiring or training staff

- Redirection of the human workforce toward design and creative roles rather than manual labour

The true efficiency gains from automation at this scale are not currently quantifiable, given the unprecedented and ever-evolving nature of AI, model, and algorithm improvements, alongside broader societal adjustment to shifting labour pools from manufacturing into creative and technical roles. However, one thing is certain: there will be substantial gains in raw throughput, processing volume, and turnaround time.

Orchestration and Control: Introducing the Factory Management Portal (FMP)

The final part of the NGMF architecture is the management and interconnectivity of everything discussed above. Reliable automation is impossible without a rock-solid back end — a digital central nervous system that commands every machine and conveyor belt with millisecond precision: an instantaneous, all-knowing overseer that orchestrates every electrical and mechanical system, monitors the input and output of each subsystem, and manages power consumption and raw resource stockpiles. It is capable of managing quality control and site security, routing automated trucks and forklifts, and providing automatic pick-and-replace capabilities to every subsystem along the production line.

Connecting and aggregating the massive amounts of data involved in such deep levels of automation is no easy task, and has historically been the exclusive domain of cutting-edge foundries and facilities running internal, proprietary control systems — accessible only to operators such as Intel and TSMC. However, the same efficiency principles can be applied to any facility or production line by leveraging the lower barrier to entry in robotics and AI automation, HVDC SMPS infrastructure, and high-efficiency motors and controls.

Introducing the Factory Management Portal (FMP): our answer to the challenges involved in integrating and controlling mission-critical control systems ingrained deep within the fabric of any production facility. FMP began as the civilian-facing extension of the control architecture originally built for our defence R&D division — software developed to manage drone defence systems and life-saving equipment under the strict security and chain-of-custody standards required for ITAR-restricted materials. That same ground-up, modular codebase is now being adapted to run Gholdram's own future production facilities, and to be made available to manufacturers facing the same automation and security challenges, at a fraction of the cost of legacy industrial control systems.

Where this approach differs most from existing high-end industrial control systems — the kind run internally by foundries like Intel and TSMC — is accessibility. Those systems are proprietary, closed, and built for organisations with effectively unlimited capital.

A small recycling plant or a mid-sized CNC shop will never be a customer for a multi-million-dollar enterprise contract, no matter how much value the underlying technology could provide them. By building on open-source frameworks wherever practical, favouring off-the-shelf components over custom proprietary hardware, and pricing for the small-to-medium manufacturer rather than the conglomerate, FMP is designed to bring foundry-grade automation within reach of businesses that have historically been priced out of it entirely.

The FMP allows site-commanding personnel and C-suite executives to manage an entire factory from an ordinary tablet or laptop, anywhere in the world — from viewing and managing each production line's performance and output levels, power consumption, and quality control, to automatically scheduling downtime and maintenance routines when faults occur.

When an issue is detected that requires a human decision for safety reasons, the site operator can issue a command, and the automated subsystems handle the rest. If equipment needs immediate replacement, automated forklifts will automatically pick and place the replacement machinery from the equipment repair depot.

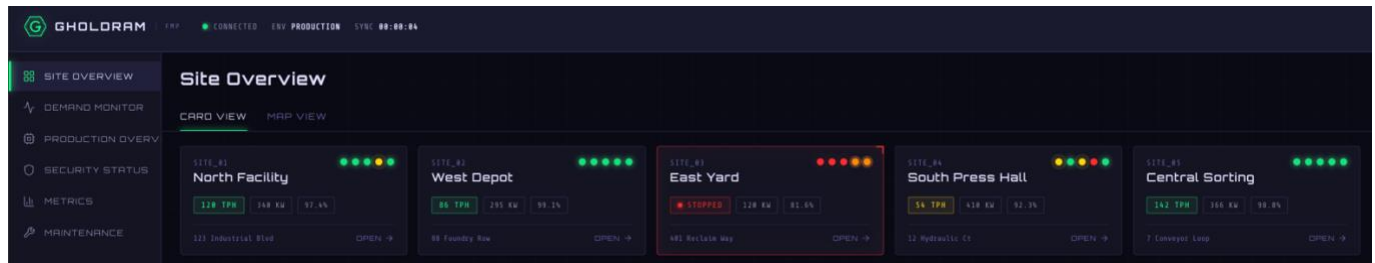
Capabilities and Efficiencies Gained by Integrating FMP with NGMF Architecture

- 24/7 facility and performance monitoring
- Tight resource management and accurate delivery scheduling
- Total authority over every machine and production line
- Maximum security via CCTV integration and chain-of-custody tracking
- Weighing-station and scale tracking for shrink and loss recovery
- Plug-and-play compatibility with green energy generators and battery banks
- Facility power consumption optimisation based on grid utility pricing
- Grid net-metering and energy resale management
- Real-time accounts payable and receivable monitoring
- Telemetry archives for environmental monitoring and compliance grading
- Facility duplication for rapid scaling of proven setups
- Real-time management of unlimited facilities
- Automatic assignment and management of human personnel and robotic assets

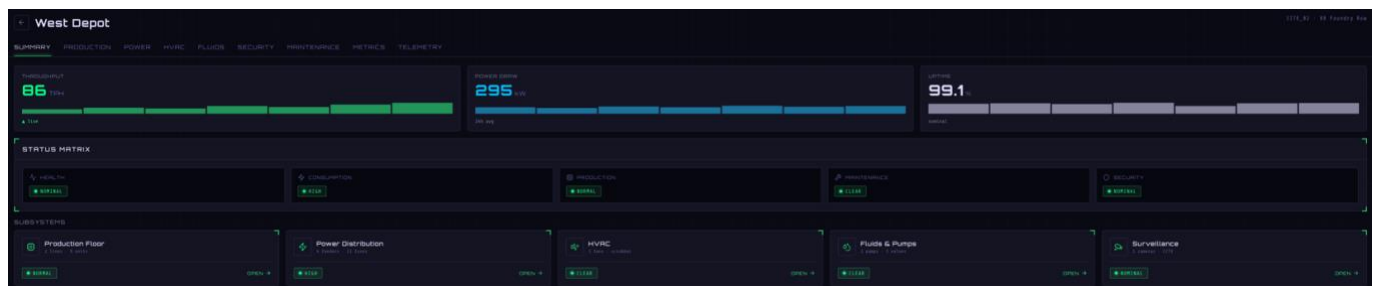
The following screen captures are from a prototype build of our FMP software, providing a visual demonstration of the FMP interface and how it integrates with the NGMF architecture:

FMP Interface — Software Demo

Control and C-suite staff — referred to internally as “sudo” — can select any FMP-connected site after logging in:



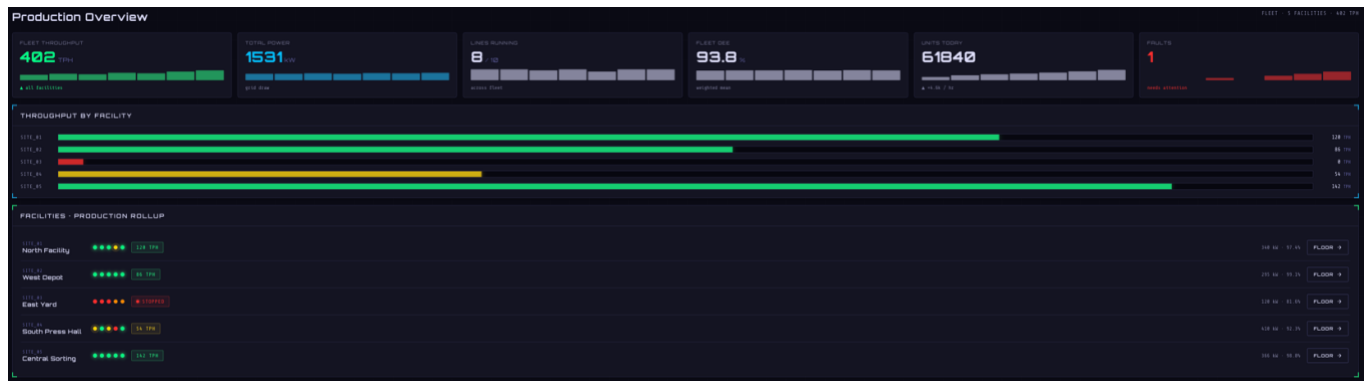
Summary tab provides a general performance overview of the specific facility in focus (West Depot for this demo):



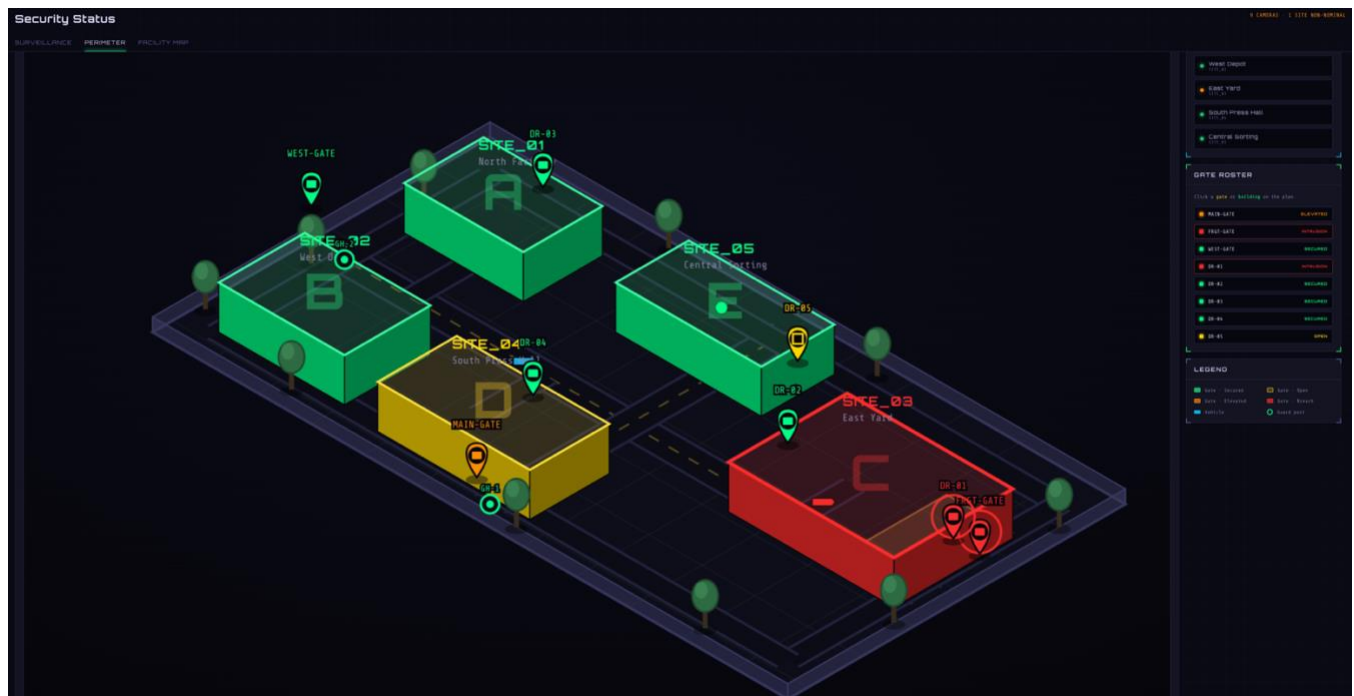
sudo can also view and manage electrical & green energy resources and their performance:



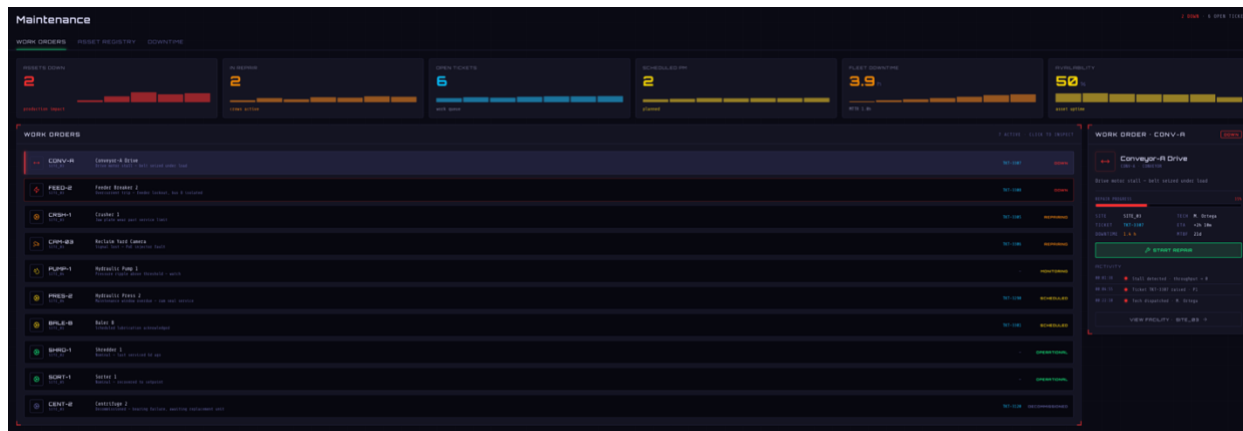
sudo can also view the combined performance of all facilities connect to FMP at the same time via the “production overview” master tab:



Sudo can also monitor facility security, camera feeds, intrusion & traffic alerts:



Maintenance can be automatically scheduled upon detection or queued independently by sudo:



Conclusion

Facilities outfitted with NGMF architecture and integrated with FMP can achieve outstanding performance improvements and cost reductions across nearly every step of the business model — from labour costs and accounting to shrink reduction and increased throughput. Any business looking to future-proof and unify its production pipeline can take advantage of our FMP backend and its virtually limitless automation possibilities.

Gholdram is currently raising its Series A and actively building relationships with manufacturers and industry partners who share this vision. If your organisation is exploring automation, efficiency, or modernisation of its production pipeline, we'd welcome the conversation.

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