STRATEGIC BRIEF

In-House Manufacturing for Hardware Development Companies

Opportunities, risks and requirements for setting up your own SMD, THT, assembly and test production

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www.emssg.com | LinkedIn: Dirk Kaussen

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Note regarding the scope of this document

The question of whether and how a hardware developer should establish its own manufacturing facility for SMD assembly, through-hole processing, assembly and testing is highly individual. Product mix, production volumes, product variety, target markets, certification requirements and available capital can fundamentally change the answer in each case. A complete analysis of all advantages and disadvantages, as well as all requirements for an individual situation, would easily comprise 100 pages or more.

This Strategic Brief therefore deliberately focuses on the essentials. It outlines the key arguments, typical pitfalls and most important prerequisites to help ensure that an in-house manufacturing project does not fail during its initial stages. I would be happy to discuss how these considerations apply to your specific situation, including production volumes, investments and certification requirements.

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1. Initial situation

Once a hardware product is ready for series production, many developers, start-ups and hardware companies face the question of whether to outsource manufacturing to an EMS provider or establish production in-house. The desire for in-house manufacturing usually stems from a combination of several motives. These include greater control over quality and processes, protection of intellectual property, independence from external capacities and lead times, and the expectation of lower costs.

These motives are understandable. However, they do not answer the question of whether in-house production is economically and operationally viable in a specific case. This is precisely where many projects fail – not because of a lack of commitment, but because the necessary prerequisites are underestimated.

Modern manufacturing is no longer just about machines, personnel and production space. In addition to the physical production processes, data flows, quality management, material supply, maintenance and regulatory requirements must also be reliably managed. Depending on the target market, this can involve significantly higher organizational and financial costs than the initial machinery investment alone might suggest.

2. Advantages of in-house production

- **Control:** Direct control over quality, processes and delivery schedules without the need to coordinate with an external service provider.
- **Short development-to-manufacturing paths:** Changes to the PCB layout or bill of materials can be implemented without coordination loops with an external partner.
- **IP protection:** Critical process and product know-how remains within the company.
- **Flexibility for small production runs:** Prototypes, pre-series production and small batches can be integrated flexibly without the minimum quantities or setup costs associated with an EMS partner.

- **Independence:** No dependence on capacity bottlenecks, lead times or prioritization decisions made by an external manufacturing service provider.
- **Positioning:** Having in-house manufacturing capabilities can serve as a trust and procurement criterion in certain markets, such as medical technology, defense and critical infrastructure.
- **Direct data and process access:** In-house manufacturing allows a closer connection between development, production data and manufacturing processes. However, this requires an appropriate digital infrastructure.

3. Disadvantages and risks

- **High capital requirement:** Machines such as pick-and-place equipment, reflow ovens, AOI systems and, where required, wave soldering systems, together with production premises meeting ESD and environmental requirements, as well as tooling, tie up significant capital before a single product is manufactured.
- **Skilled personnel requirements:** SMD programming, equipment maintenance, quality assurance and process optimization require skilled personnel who are often scarce and expensive on the labor market.
- **Lack of economies of scale:** A specialized EMS provider manufactures for multiple customers simultaneously and can therefore distribute material, equipment utilization and personnel more efficiently. A single hardware manufacturer typically cannot achieve the same level of efficiency.
- **Lower purchasing power:** Without consolidated purchasing volumes, negotiating power for components is limited, which can become particularly disadvantageous during supply shortages.
- **Certification effort:** Depending on the target market, ISO 9001 and industry-specific certifications may be required. ISO 13485, for example, may be relevant for medical technology, while IATF 16949 may be required in the automotive sector. These systems go significantly beyond the requirements of general ISO 9001 certification and can involve considerable additional effort for processes, documentation, qualification and audits.
- **Compliance with IPC technical standards:** In addition to organizational certifications, technical quality requirements must also be met. IPC-A-610 serves as an important reference standard for evaluating electronic assemblies; depending on the product, application and customer requirements, manufacturing may need to be designed to meet IPC Class 2 or Class 3 requirements. This requires suitable processes, qualified equipment and appropriately trained personnel.
- **Capacity utilization risk:** Fluctuating or insufficient production volumes lead to underutilized equipment and consequently high unit costs – the opposite of the original cost objective.
- **Maintenance and spare parts:** Machines incur not only acquisition and depreciation costs. An ongoing budget must also be allocated for maintenance, wear parts, spare parts and technical support. As a rough planning guideline, approximately 3–5% of the total investment can be assumed per year, depending on the equipment and machinery involved.

- **Distraction from the core business:** Setting up and operating a manufacturing facility ties up management resources that would otherwise be available for product development and market launch.

- **Digital infrastructure:** Modern manufacturing requires not only production equipment but also appropriate software and data structures. MES, ERP integration and a seamless data flow from development and CAD through production planning to the machine level should be considered from the outset. Otherwise, new manual interfaces and potential sources of error can arise.

- **Regulatory and environmental requirements:** Energy consumption, consumables, waste and disposal processes, as well as documented environmental requirements, can become part of customer requirements and audits. In-house manufacturing therefore also assumes responsibilities that may already be integrated into established systems at an EMS partner.

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4. Focus on manufacturing areas

For hardware developers considering in-house manufacturing, four core areas typically need to be considered – supplemented by a possible fifth area if the product requires cable assemblies or harnesses.

SMD assembly

Automated component placement – including solder paste printing, pick-and-place, reflow soldering and optical inspection/AOI – is the most technologically demanding and investment-intensive area. It is generally only economically viable above a certain minimum production volume, as setup times, programming and equipment depreciation can otherwise have a disproportionate impact on unit costs.

In addition, production programs, component data, test programs and process data must be reliably managed. As automation increases, the digital connectivity of the production equipment therefore becomes increasingly important.

THT / manual manufacturing

Through-hole components are typically inserted manually. For larger production volumes or a high number of through-hole components, insertion can also be automated. Depending on the assembly, the subsequent soldering process may use wave soldering or selective soldering. Compared with SMD production, the investment requirement is generally lower. However, this area often remains labor-intensive, and quality – particularly in manual operations – depends significantly on the experience and qualification of the personnel.

Assembly

Final mechanical assembly, including housing assembly, fastening, bonding and labeling, can often be carried out internally with comparatively moderate investment. It is therefore frequently suitable as a first step toward in-house manufacturing before SMD or THT capacity is established.

Testing

Functional testing, in-circuit testing (ICT) and, where required, burn-in procedures help ensure product quality. The test concept and test fixtures should already be considered during the development phase. Test procedures introduced only at a later stage are generally more expensive and less effective.

Cable assembly (if relevant)

If the product contains cable harnesses or cable assemblies, this represents a separate manufacturing area with its own requirements for tooling, crimp quality and testing procedures. It is only briefly addressed here because, in practice, cable assembly is often organized separately – either internally or externally – and deserves its own detailed assessment.

5. Prerequisites for avoiding failing

- **Realistic production volume planning:** A sound make-or-buy calculation based on realistic production volumes and product variants should be the starting point of every decision – not an exercise carried out at the end.
- **Consider total costs rather than investment costs alone:** In addition to machinery and equipment, personnel, energy, maintenance, spare parts, consumables, scrap, training, software and underutilized capacity must also be considered. Only a comprehensive Total Cost of Ownership (TCO) analysis can show whether in-house production is actually more economical.
- **Sufficient investment budget:** In addition to the initial investment, a financial buffer must be planned for the ramp-up phase. Scrap rates, the learning curve and process optimization can consume a disproportionate amount of time and money during the first few months. Ongoing maintenance and spare parts costs must also be included in the investment decision.
- **Secure qualified personnel in advance:** Equipment programming, maintenance and quality assurance must be adequately staffed before the equipment is ordered – not after installation has already begun.
- **Build process know-how:** Purchasing a machine does not replace process expertise. Soldering, assembly and testing processes must be actively developed, qualified and documented.
- **Plan digital infrastructure from the start:** Modern manufacturing requires a seamless flow of data between development, production planning and manufacturing. CAD and bill-of-materials data, manufacturing programs, test plans and production data should be transferred with as little manual intervention as possible. Depending on the scale of production, MES solutions and integration with the ERP system can provide an important foundation.
- **Quality management from the very beginning:** Quality management should be considered from the outset rather than introduced only when a customer demands it. ISO 9001 can serve as a foundation. However, depending on the target market, significantly more comprehensive requirements may apply, such as ISO 13485 for medical technology or IATF

16949 in the automotive sector. The required level of certification should therefore be clarified before the investment decision is made.

- **Consider sustainability and regulatory requirements:** Energy consumption – for example for reflow and soldering processes or nitrogen supply – as well as waste, consumables and disposal should be considered during the planning phase. Even if these factors do not always determine the investment decision, they can be relevant to customer requirements, audits and the long-term operating cost structure.

- **Realistic timeline:** Equipment procurement, process setup and, where required, certification often take 12 to 18 months or longer in practice. This timeframe must therefore be incorporated into the strategic planning.

- **Scalability concept:** What happens if demand exceeds in-house capacity? A strategy for external capacity or future capacity expansion should be considered from the outset.

- **Open coordination with the existing EMS partner:** Early involvement of the existing manufacturing partner creates transparency and preserves strategic options. If the establishment of in-house manufacturing proves unsuccessful or uneconomical, returning to external manufacturing remains significantly easier.

Supply chains and expertise are integral to virtually all of the prerequisites outlined above. Without a secure supply of materials and established process know-how, none of these measures will be sustainable. However, both topics are sufficiently extensive to warrant separate treatment and are therefore not explored in detail here. Supply chain management and manufacturing knowledge development are independent disciplines with their own methodologies, even though manufacturing cannot function effectively without either.

6. Hybrid model: using in-house production and an EMS partners in parallel

In-house production and outsourcing are not mutually exclusive. In practice, some OEMs deliberately use both approaches in parallel: part of the production volume is manufactured internally, while another part remains with the existing EMS partner. This model is particularly useful when total production volumes are high enough that in-house capacity alone is insufficient, while fully internal manufacturing would not be economically justified.

The advantage lies in risk distribution. Fluctuations in the utilization of the in-house production line can be absorbed by the EMS partner, while internal manufacturing remains available as a basis for control, process development and learning. A clear allocation is essential – for example, by product variant, customer project or capacity peak – so that both sides can calculate their economics transparently and no competitive situation develops between internal and external manufacturing.

The hybrid model can also support a gradual investment strategy. For example, assembly, testing or selected manual processes can initially be brought in-house, while capital-intensive and highly capacity-dependent areas such as SMD assembly remain outsourced.

Assessment

For most early-stage hardware developers, starting with a qualified EMS partner is the lower-risk approach. It avoids the capital commitment and capacity utilization risk of in-house production while production volumes and product variety are still unstable.

In-house production becomes more attractive when IP-critical processes need to be protected, when very small and frequently changing batch sizes undermine the economics of external manufacturing, or when production volumes can already be forecast reliably enough to ensure adequate utilization of the internal capacity.

However, the evaluation should not be limited to machine and personnel costs. Digital infrastructure, quality and certification requirements, energy and operating costs, as well as maintenance and spare parts, should also be included in the economic assessment.

The transition does not have to be an all-or-nothing decision. A step-by-step approach – starting, for example, with assembly and testing, followed by THT and only later SMD – can significantly reduce the investment risk.

7. Conclusion

In-house manufacturing can be a strategic advantage for hardware developers – but it is not a given and, in most cases, it is not the cheaper solution once all costs and organizational requirements are realistically taken into account.

Anyone taking this step should base the decision on a robust production volume plan, sufficient capital reserves and a realistic timeframe. The evaluation should include not only machinery and personnel, but also maintenance and spare parts, energy and operating costs, digital infrastructure, quality management and, where applicable, industry-specific certification requirements.

Digitalization is often underestimated in this context. Modern in-house manufacturing requires not only high-performance production equipment, but also a reliable data flow between development, ERP, production planning, MES and the production floor. Sustainability, energy efficiency, and waste and disposal requirements should likewise be considered at an early stage.

The decision does not necessarily have to be an either-or choice. Particularly with high and growing production volumes, a parallel model – in-house manufacturing for part of the volume and an EMS partner for the remainder – can be the more viable solution. It reduces capacity utilization risk and investment pressure without giving up the advantages of internal manufacturing.

If this approach is openly coordinated with the existing EMS partner from the outset, it also remains viable if individual assumptions subsequently prove to have been too optimistic.

The central question is therefore not simply whether in-house manufacturing is technically possible, but whether it is sustainable in the long term when capacity utilization, TCO, personnel, digitalization, quality, regulatory requirements and strategic flexibility are taken into account.

This Strategic Brief outlines the fundamental framework. I would be happy to provide an individual assessment of your product, production volumes and target markets – including a specific make-or-buy analysis.

About the Author

Dirk Kaussen is Founder and Managing Director of EMS Strategy Group. With around 40 years of experience in the electronics industry — including founding and managing his own electronics manufacturing company in Germany — he brings deep expertise in manufacturing processes, EMS partner selection, supply chain stability, relocation projects, and risk management. His approach combines practical solutions with a direct connection to industrial reality.

About the EMS Strategy Group

EMS Strategy Group supports industrial enterprises in the strategic and operational advancement of their electronics manufacturing. Our core expertise lies in the strategic relocation of manufacturing volumes, the selection of qualified EMS partners, the establishment of new production capacities, and the expansion of existing manufacturing structures.

Furthermore, we design resilient supply chain frameworks, conduct comprehensive risk assessments, and guide dual-sourcing strategies, with operational support through to a successful series production ramp-up.

www.emssg.com | *LinkedIn: Dirk Kaussen*

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