SIP Manufacturing Start-UP

A review of the startup process

Revised 2022

Overview

Manufacturing Structural Insulated Panels (SIPs) is like any manufacturing endeavor. It requires research, time, money, and a plan. If you're reading this paper, it's quite possible you are in the midst of research. If your intention is to move forward with making SIPs (Either for your own use or selling to the general public), there are a lot of steps to getting it right. I've worked with many companies and individuals who all wanted to get into the game. Writing this paper was my way of outlining the conversation I've had many times over the past decade. I believe it will assist in preparing you for the many issues that will be encountered and the many questions you'll need to address as you move forward. In no way will this short read address all items for all startups. It is meant to be a high-level view to prepare you for taking the leap into the SIP industry.

Experience

It never ceases to amaze me the number of people who have contacted me to discuss a SIP startup since I declared myself a consultant to the industry 15 years ago. Unfortunately, a sizable number of those contacts were void of any real experience in the world of manufacturing. Worse still, they had little to no experience in using SIPs. Its as if they read an article about SIPs and convinced themselves that this form of construction was the next hot trend and they needed to get started while the opportunity was still near the ground floor. To add insult to injury, the notion of being the next SIP tycoon was misguided by an assumption that gluing two skins of something to a single core of some type of foam was so easy that anyone could do it. As an aside note, I would say that last misperception is exactly why we've seen several true "Fly-by-Night" SIP scammers. The thought of easy money was quickly replaced with how hard it is to be a quality driven manufacture and still be able to turn a profit. The result is "garage-Shop" panels being pressed with piles of concrete blocks or drums of water that belie the very nature of the high-tech construction alternative. This followed by a SIP being produced without any QC or testing and results in one of the many SIP fails that you've probably read about.

If you and your team (I'll assume you have a team) have real manufacturing experience in the ranks, you've got a leg up and will shorten your learning curve substantially. If your team is lacking that experience, find a person who has worked in some form of lamination and/or wood working. The industry of lamination and the use of presses is pervasive in most manufacturing operations that you can think of. Having a person that possesses knowledge about running a plant while being able to speak reasonably competently about systems that include electrical,

controls, pneumatics, hydraulics, vacuum, drive systems, thermodynamics and many more will be invaluable. In short, you need a mechanical engineer or similar that is system capable in many areas.

Additionally, your team needs real SIP experience. It wasn't until I spent a week on a SIP job in the early 90's installing panels that I personally manufactured the previous week did I realize how many issues of tolerance could influence the success of the install. There is no substitute for actually building with SIPs to best understand what makes a good panel. If you have a long history of using SIPs in the field and are merely transitioning into manufacturing, you will be far ahead in understanding the importance of Quality Control and what areas you need to be perfect and what areas can allow a less stringent tolerance.

When I'm approached by someone who has no team or no discernible experience, and is ready to start buying equipment, I realize that it is in both of our best interests to put the brakes on. I recommend that an inexperienced entrepreneur first develop proof of concept and at the same time gather some experience. My recommendation often goes something like this: Develop your local market by being (or partnering with) the local SIP builder. Use that time to test the regional market and seek out amiable builders and architects. At the same time, gauge the acceptance of the local code officials. During that time, you can source your SIPS from an established manufacturer and develop your business plan while you build your experience in putting panels together.

Planning

A plan to get into making SIPs needs to be on par with developing and writing a business plan. It takes time and it can be draining. However, it's time well spent when you discover how it affects you needs related to equipment, building size, workforce, etc. The first question I'll typically ask has three parts. What type of panel will you make? What size will you make? What is the production capacity that you anticipate over the first three years?

The type and size of panel is often a function of local architecture and cultural bias. For instance, you would be ill-advised to make a jumbo SIP (8' X 24') in an area where heavy equipment is not readily available. In addition, you would be wasting your time making an OSB skinned SIP in Central America and much of the Northern region of South America. In those areas, a wood structure is perceived to be cheap and temporary. The cultural perceptions make that businessplan a non-starter.

The biggest input for decision making clarity is the number of panels you want to produce in a shift, week, month, or year. These numbers drive the calculations that determine what type of lamination and pressing setup you will need. To further that discussion, I strongly recommend having a plan for expansion. Will you need an expandable line? Can you double throughput by

simply adding a second press? Additional items that need to be thought out include type of skin, type of core and type of adhesive. To be clear, they all have advantages and disadvantages. One of the biggest areas of confusion lay in the pros and cons of different SIP skins. However, we'll talk more about panel types a bit later.

Budget

Seldom do a take an enquiry about consulting for a new startup where the perspective client tells me they want to spend North of a million dollars. In fact, most of my "first time" conversations have me believing the caller is searching for a number that won't make me laugh. Unfortunately, they could tell me any number between $100 and $100 million and it's a meaningless number without a whole lot more information (Namely "How many panels a year do you plan to make with your hundred-dollar investment?)

In short, the budget is tied to your plan. If your plan hasn't been planned, your budget is just a number.

Items that will affect your budget and be affected by your budget include:
Throughput (capacity)
Type of lamination
Level of automation
Workforce training (experience)
Building and existing mechanical systems
Level of fabrication (and associated automation)
Level of certification, compliance, and testing
Quality Control Program
Training for production, design, sales, engineering, marketing, etc.

I've helped setup a SIP operation in Central America that was a one-man operation. However, that one man was an aero-space engineer and knew his market. He had experience in construction, and he got as much training as available to him at the SIPschool. He invested in a used 4' x 9' press and bought a refurbished glue spreader at a Chicago auction. He started making cementitious skinned SIPs for an initial investment of less than $100K. It should be unnecessary to point out that he has zero automation and very low throughput. He does have a simple operation with QC guidelines that ensure his panels will conform to the desired level of structural performance. That's my shining example of doing it on the frugal side.

If you want to look at the opposite end of the spectrum, You can invest many millions like most of the larger SIP manufacturers in North America. This would have you making jumbo SIPs at a rate of about one every 10 minutes with some levels of automation. In addition, your CAD-CAM connected design department would be sending cutting instructions directly to a fully automated panel saw that improves throughput and decreases labor costs.

I understand that any sound businessperson wants to get the most bang for the buck and profitability drives most, if not, all decisions. However, your plan and your budget must match. Depending on the level of speed, sophistication, and automation with a heavy dose of overall capacity, you should plan to spend (in North America) at least $500K. That amount of investment will get your foot in the door with a low-capacity production line that can produce a code approved panel. If you're going to run with the big dogs, you'll need deeper pockets. With CNC cutting and semi-automated panel lamination, you will quickly find your investment hovering around 5 million. It's important to remember that a big part of your initial investment may need to be earmarked for testing, engineering, and compliance fees. We'll talk about that more later.

Type of Panel

You're kidding yourself if you think the salesman that represents the product you are considering gave you an unbiased list of his materials disadvantages. Nor did he fairly represent the competitions advantages. These issues should not be overlooked as the wrong type of panel in the wrong area is certain failure. It is arguable that an honest and experienced consultant is most useful in navigating the sales hype and pitches that often draw people towards an incorrect conclusion. I've laminated almost every type of skin ever to be used that can be called a panel. I've worked with every type of foam and dozens of different adhesives. My facility in Florida was opened specifically to do R&D for SIPs and has seen a lot ofoff-spec laminations. I had partial ownership in a plant in South America that started out laminating MgO exclusively. I've dealt with a lot of good and bad panels over the years. My advice is to understand the market to determine which type of panel you commit to.

Equipment

Once you've established your budget along with your plan, you should know what you're makingand how fast you must make it. I mentioned earlier the press that was turned on by manually stacking concrete blocks on top of the stack of freshly laid panels. Equally disturbing should be the picture I was once sent of two workers spreading adhesive with a paint roller while making SIPs. The lack of QC demonstrated while making a building component that must perform structurally makes me slightly queasy. The very nature of SIP manufacturing involves using expensive adhesive that delivers a structural bond. However, that bond is a function of proper application, and that bond depends on many things including: spread rate, time, temperature, pressure, substrate, and humidity. If these variables are ignored, bad things can happen. The foundation of SIP manufacturing equipment is the glue delivery machine. This can come in the form of a glue spreader which applies a controlled spread rate on one or both sides of the core.Or, it can be an extruder which applies beads of adhesives at a controlled rate to, again, ensure proper spread rate. Both machines have advantages and disadvantages. The selection of which machine is best for your operation falls again to the work you've outlined in your plan andbudget.

The second station of SIP production is the press. This machine simply applies pressure long enough for your adhesive to bond properly. Presses come in many shapes and sizes and price ranges. Again, they all have advantages and disadvantages. Your options for presses include vacuum, pneumatic, hydraulic, or pinch roller. The glue delivery system is greatly influenced by the type of glue you select. These options include water based, moisture cured urethane, and hotmelt. Have I mentioned that they all have advantages and disadvantages?

In addition to the big-ticket items like glue spreaders and presses, you'll need several smaller pieces of equipment to consider. See the list below

- Alignment tables
- Transfer tables
- Scissor lifts
- Air compressor
- Material handling carts, cranes, forklifts
- Cutting tables
- Wire cutting station
- Wire Chase drill station
- Unwinding, tension and shear station (applicable to metals and composites)
- QC test station
- Edge routing station
- Gang saw for spline ripping
- Roll former for metal connecting components
- Dust collection station
- Lighting
- Hand tools out the wazoo

Code Approval (Testing)

Depending on the Country you plan to produce and sell your SIPs, this section could be either amazingly difficult of relatively painless. Since I got my start in the States, I'll start there (or here). Code compliance is a complex and fickle beast. It often makes little sense and always seems to cost more than you think it should. There are various degrees of compliance and there are individual States that tack on additional requirements because they can. If you plan to make panels only for yourself and your projects, you can forego the insanity and simply use a professional engineer to assume the liability of proper structural design. This method assumes you have a relationship with a PE that accepts the notion that your SIPs are produced to a minimum standard every time and the panel's structural characteristics can be assumed for the sake of structural calculations. Hence, you need a PE that knows SIPs and one that has a warm comfortable feeling with your operation and its level of QC compliance.

If you plan to sell your SIPs to the general public, you will need code compliance in the form of an Evaluation report or similar to ease the minds of the local building inspectors.This assumes you even have a local building inspection department. It shouldn't surprise you that a good percentage of the 50 States have no enforceable building code. That's not a licenseto sell a defective panel. It's just a fact that means a lot of home buyers don't rely on State, County, or city inspectors to protect them from unscrupulous builders. If you're selling your panels on a commercial project, You will need (the vast majority of the time) to show code compliance.

How does one get a certificate to show code compliance? There are several paths with different timelines and costs. If you plan to tackle this beast all by yourself, I would recommend you allocate about $180K and at least 6 months. If you elect to jump on the SIPA train, (Short for Structural Insulated Panel Association code committee) you will find an expedited path with a few qualifiers. First, you must become a SIPA manufacturer member. Secondly, you must be planning on making an OSB SIP. The SIPA path allows you to be shown as a "listee" on the associations own code report. In addition, a membership to SIPA is tied to your commitment to have PE reviewed and stamped load design charts as well as a 3rd party QC inspection program.The program that SIPA setup will fast track you to an ESR in about 3 months for much less than
$100K.

NOTE: The SIPA requirement for manufacturing members includes the three items mentioned above. 1) Code compliance 2) load design charts derived from testing and an engineer 3) A 3rd party QC program with quarterly inspections

It is these three requirements that give the SIP-buying public a strong level of confidence when choosing their supplier. I encourage you to strive for a similar level of testing and Quality Control.

If you're inside the US but not using OSB, you'll need to consider your options and ascertain if a code certificate is worth the investment. It should be obvious that the SIP industry is dominated by OSB and its early adoption by the APA (Engineered Wood Association) is the reason that SIP testingwith OSB is winning the race. It doesn't mean that OSB is better. It simply means they have more testing and a longer history of successful compliance.

If you are outside of the US, your requirements will be driven by the Country's building code. If you are in an "emerging" Country that might be referred to as 2nd or 3rd world, the standards of building codes are often blurred or nonexistent. In these cases, I often fall back to a USA standard and use local engineers to confirm structural compliance.

Testing protocols are well established, and we can use test labs worldwide to test the SIP produced. These main tests are axial, transverse, racking, and shear. The process is very time consuming and having a knowledgeable ally on your team can be immensely valuable to the speed and ultimate cost of obtaining code certification.

Design

SIP design should not be confused with Architectural design. It is very common for SIP manufacturers to receive architectural drawings for the sake of quoting or converting to a SIP layout drawing. Also referred to as panel layout drawings, a SIP manufacturer will manipulate the panel configuration and joints to allow the SIPs to create the structure depicted on the architectural drawings.

If your new startup is planning to provide fabricated panel packages as opposed to nothing but blank panels, you'll need to pay attention to this and the next chapter.

Manufacturers use several different drawing programs. AutoCAD still reigns supreme as the most often used but a few fabrication focused software packages are becoming widely used. These CAD programs interface with CNC equipment to give the manufacturer CAD-CAM capabilities. This is only a significant leap forward if the manufacturer happens to have purchased a CNC fabrication line. Many SIP manufacturers around the world still hand cut panels using various hand tools to negotiate the process.

If you elect to setup a design team to support your manufacturing efforts, you should budget between $5K and $35K for the software alone. You'll still need computers, plotters and training.

Fabrication

I visited a factory in Austria in the 90's to meet a man named Hans Hundegger. Hans company had developed a CNC saw known as the PBA. This massive piece of equipment was an engineering marvel and in the 20 plus years that Hans has been making PBA's, they've become bigger, more impressive and more expensive. If you have your heart set on some high-end CNC fabrication, you'll need a million USD and the patience to wait about two year. (Seems the growth in Cross laminated timbers has made Hans a very busy man). If a used one comes on the market, it's usually snatched up before it becomes common knowledge. There are other companies and other forms of CNC fabrication. However, every path comes with a price tag for the equipment, the software interface, the setup, and the training.

If you elect to forego CAD-CAM and instead put more people to work, hand cutting SIPs is an option. It can be efficient and accurate. It simply takes the tools, training, and the process to deliver a hand-cut package that is within the tolerance of acceptable. I regularly teach classes at the SIPschool where we introduce students to all variations of hand tools and techniques used to hand-fabricate SIPs. In most cases our students are using this training for field fabrication. However, it can easily be applied to factory operations. A well-equipped fabrication shop that cuts by hand will have invested 20-50 thousand dollars.

When you think of fabrication, don't stop at the saw alone. Remember that panels need edge routing or profiling to allow the spline or plate to fit between the skins. These processes take many different types of routers, grinders, planer, etc.

Operations

I choose this chapter to speak mostly about two crucial items needed to manufacture quality SIPs. You'll need a QC manual and a Standard Operating Procedure.

The first allows you to pass your 3rd party inspection every quarter. A QC manual is your roadmap to ensuring that all aspects of production are within prescribed guidelines. It dictates your paperwork and the filing of production records. Part of my work for clients is to develop a complete manual that provides direction and tolerance on all incoming raw material as well as outgoing processed panels. A well-choreographed QC program will give piece of mind to your customers as well as yourself. It cannot be overstated the importance of embracing the need and then developing and following the manual that separates you from the shirtless men spreading glue with paint rollers.

A Standard Operating Procedure is an instruction manual for all production. It includes items such as equipment startup and shut down procedures, how to clean a machine safely and efficiently, equipment maintenance schedules, floor layout and control areas. In short, the manual is the instruction book to assist in training and operating the plant safely and efficiently. A well-rehearsed procedure is one that minimizes downtime, lost work hours and maximizes employee confidence and profitability.

Both items have a cost to produce and follow. The cost is exactly priceless.

The last thing I'll address in operations is the layout of your space. I've worked in SIP plants that were as large as 100K SF and as small as 5K SF. I would estimate that most large SIP operations use 50-80K SF to laminate and fabricate packages. I'm often engaged to develop pant layouts. A keen understanding of material flow and various processes is critical to a layout that avoids congestion and unsafe situations. You will need to evaluate your building or potential building for an appropriate layout of equipment and workstations. This process includes the layout and design of all subsystems such as electrical, compressed air, dust collection, lighting, etc.

Sales

A new startup needs to address the needs of a startup sales force. This would include training and more training. The most successful SIP salesman usually has a history of SIP building. The surest way to understand the system is to have installed it. I'm a big fan of sales training and most of that training is overcoming objections. Seems a lot of negative information can be

found on the internet about almost anything and SIPs are no exception. The key is to have a well-rounded understanding of SIPs and not just a list of talking points. A sales training session is a wise investment.

Success

Your endeavor to become a SIP manufacturer is reasonable. However, if you hope to be successful, I hope that you will consider what I've laid out before you. I often tell clients that 'It's not hard to install SIPs but it's really easy to install them incorrectly. The same can be said about SIP manufacturing. It's not hard to make them. But, it's really easy to make them poorly.

The hard part is not putting glue on a substrate followed by some pressure and time. The really hard part is getting design to communicate with fabrication and getting sales to communicate with engineering all the while having operations follow procedures while you control the flow of raw material, people and money. Now go start planning.

To your success.