TOP TEN LESSONS LEARNED COMMERCIALIZING ADVANCED BIOTECHNOLOGIES

Mark Warner, P.E.
Founder, Warner Advisors

Spending half a billion dollars placing steel in the ground to commercialize advanced biotechnologies for fuels, chemicals and food applications, is the easy part. Doing it successfully is the hard part – but I have been fortunate to lead many successful projects over the last ten years, and that is what has prompted me to share my personal experience in this three-part series of *Top Ten Lessons Learned*. I have done my best to include real world examples and attributes that make ventures succeed, as well as common pitfalls. My focus is on the technical perspectives of technology deployment, from early stage process development, engineering, and construction to a fully operational commercial facility. This series is for anyone who is passionate about scaling advanced biotechnology dreams.

PART 3 – FINANCING, STARTUP AND OPERATIONS

8. Financing - *The tail does wag the dog*

The manner in which a project is financed has a dramatic impact on how the project can and needs to be executed. In the case of equity funding, the key decisions are with the company and projects can move very rapidly. The proof of concept of the technology and responsibility for key decisions, like purchasing major equipment, does not require outside approval. This is generally the gold standard of project funding from the engineering perspective and allows for the fastest project delivery. Unfortunately, it is not that common, especially for large expensive facilities, as it creates dilution for existing shareholders if significant capital is raised as equity.

The other end of the spectrum is traditional project finance where a bank loans a large portion of the money, but has significant restrictions and approvals. They will likely require a third party assessment of the technology, review all contracts for feedstock supply and product offtake, and require sign off on all major equipment purchases. As most new technologies do not have all these details locked down, traditional project finance is not common in new technologies. If used, the project timeline will need to reflect all these approvals and will need to be extended.

The most common form of financing for new technologies is a hybrid of equity, teamed with either a federal grants or a federally backed loan guarantees. In the case of grant, it is a source of funding that does not need to be paid back, but it is subject to meeting a series of technical hurdles. Loan guarantees look a lot like a traditional project finance, but the government accepts the technology risk and backs the loan. This streamlines the approval steps and control some, but does not remove it.

The decision on type of funding is usually outside of the technical team, but the important part is that the implications are understood. Time and effort can be wasted if the project delivery approach is not consistent with the requirements of the funding source.

9. Facility Start-up – *New facilities do not turn on like a light bulb*

Nothing sends chills down my spine like seeing the "step function" production forecasts for new technologies. A date is picked for startup of the new facility and the financial modeling shows it going from no production to near capacity almost immediately. This is unfortunately more common than most would believe and is often based on a limited understanding of what is involved in bringing a new facility on line, especially a process that has never been run at the scale being built. Let's start with the basics, while there is a generic term of "start-up", this is actually a sequence of inter-related events that must be completed, as follows:

- Mechanical Completion – this is the phase of the project when the process portion of the plant are constructed and ready to be tested. Very often, secondary items such as office buildings and other non-process portions of the facility may still be under construction.
- Commissioning – first time the equipment is tested for basic functionality. Motors are rotated, valves are stroked, water is pumped around and fermentation systems go through sterile hold testing. Intent is to ensure the system appears ready to operate before live materials are introduced.
- Startup – this is the time when feedstocks are introduced and the system is tested to see if it runs as designed. Initial testing will be basic functionality, working up to increasing operating rate over time. It can typically be weeks or months until a new system is operated at design capacity, even for a short period of time.
- Release to operations – the first three steps are managed by the startup and engineering teams. They are responsible for activities from mechanical completion through startup. Operators should be intimately involved for training purposes, but the responsibility has not been passed to them. Once everything checks out and procedures are in place, there is a formal transfer of the equipment from the startup team to the operations team.

In a traditional project delivery model, each one of these steps would be completed for the entire facility before moving onto the next step. The aggressive timelines that are common in startups do not typically allow this. To save overall project timeline, portions of the plant go through these steps in a rolling manner as they are constructed. Most of the major facilities I have led the startup on in recent years have had the front end of the facility operating before the back end of the facility is complete. This can be done, but requires a strong engineering and process development team, combined with a commitment to work through issues as they arise.

There are many lessons I have learned in facility startup, but the three most common are:

- Run the plant like it was designed – very often, the sheer size and cost of the news facility can get the startup crew thinking timidly and feeling maybe they should try operating the plant in some type of reduce mode. Very often starting in a batch mode, even though the facility was designed to be continuous. This is a HUGE mistake. Running the plant outside of design is very difficult and generates more issues. The plant was designed a certain way for a reason, so run it like it was designed and when issues come up (which they will), work through them. It's the only way to get the plant online.
- Continuous processes do not run well at very low rates – the concept of turndown is important when starting up a new plant. While you want to take things methodically, most processes do not turn down more than about 3 to 1. So if you try to operate equipment at less than 33% of capacity, it likely will not operate right. Like item #1, you need to be confident in your plan and team, and plow forward. I have seen more issues generated by trying to operate at very low rates than solved.
- It is not a question of if you have problems, it is how many and how you resolve them. Even with significant pilot testing, you will have a plethora of issues arise during startup. Instruments will be determined to be the wrong application, valves will not work, lines will plug and a long list of items will be generated. While frustrating, it is the reality of startup and be prepared for it. It is very common to start up, run for a period of time to generate a list of required modifications, then shut down and make them. If it is being done correctly, each time you restart, you will see improvement and a longer period of sustained operation.

The summary lesson learned is that there is no substitute for a technically strong and experienced startup team. This should be a mix of scientific subject matter experts who know the process and chemistry, but are not necessarily experienced in plant operations. They are then teamed with an engineering team, experienced in installing and operating major equipment. The final requirement is a steadfast determination and resolve to make it work. This type of startup has historically been the most challenging and rewarding moments in my career. I have often told startup teams that it is a monumental task ahead of us, but I guarantee they will look back on it fondly at some point. I then usually clarify that point usually comes 6-12 months after the startup is complete and the exhaustion has subsided.

10. Plant Operations - *It's not grad school*

I began this lessons learned series talking about cultural team changes in the early phases that are necessary for the venture to succeed and want to return to the subject to discuss the change from discovery and innovation to ongoing operations. I have had many CEOs over the years passionately tell me that once the production facility is operational that company cannot quit discovering and innovating, and while I agree, I point out that the proper place for that discovery and innovation to occur is in the lab and pilot plant, not by making continual changes to the commercial-scale operating facility. One concept I have learned as I have moved between R&D and operations multiple times is that what makes you successful in one, can often be a problem in the other. Let me explain.

What makes a good scientist and researcher is a drive for discovery and unwillingness to accept any constraints, other than laws of thermodynamics. This is often the DNA make up that allow brilliant people to discover concepts missed by others. Most researchers are motivated by the challenge and thrive in a rapidly changing landscape.

By contrast, what makes a good production process is predictability and reliability. The knowledge that you have a very high probability of success in making your product on time and at the cost you projected. This comes from structure and standard procedures, where most good operations staff thrive.

If these two worlds seem different, they are. Both are valuable and critical for long term success in their own way, but when the worlds collide, it can make for big problems. Basic lesson learned, innovation should be focused in the lab and pilot, and when ready, transferred under a formal management of change process. Many of the development team will be used to doing "on the fly" tweaks to the process at pilot-scale and this can be very dangerous and costly at commercial-scale. I have learned that process development tried for the first time at commercial-scale can result in millions of dollars of sunk costs. This is one of those lessons I have also learned a few times and sincerely hope the warning will be heeded and not proven yourself.

<u>About the author</u>

Mark Warner is a registered professional engineer with 30 years of experience in process commercialization, focusing for the last 10 years on taking first-of-a-kind-technologies from bench-top to commercial operation. He has worked for four companies who have held the #1 spot in biofuels digest's top company list, in a range of advanced biotechnologies including biodiesel, cellulosic ethanol, phototrophic algae, heterotrophic algae and innovative food products. He is the founder of Warner Advisors, providing consulting services and acting in interim engineering leadership roles for advanced bioeconomy clients. He can be reached at mark@warneradvisorsllc.com or visit www.warneradvisorsllc.com.

Special thanks to the large and accomplished team of engineers and scientists I have had the good fortune to work with over the years. This series is a summary of lessons they have all contributed to, but there are far too many to list individually.