ARROW
ENGINEERING

2020 CANADIAN CONSULTING ENGINEER AWARDS

Engineering and Design on the Cannabis Frontier

Submission Category: Natural Resources, Mining, Industry and Energy

Innovation and Timing Key for Cannabis Sector

With the legalization of cannabis products across Canada in October 2018, an entirely new agricultural / industrial sector was created. Growing cannabis plants, formerly a forbidden activity hidden in basements, backwoods and garden plots has become, within a short time, a booming industry, attracting billions of investment dollars and international attention. As a consequence of this new status, the nascent industry generated a corresponding demand for large-scale, sophisticated facilities that could provide enough product to meet the overwhelming demand while maintaining compliance with newly imposed federal and provincial regulations. The cannabis frontier, like all frontiers, beckoned to potential stakeholders with the promise of extraordinary ROI – if one's company could beat the pack and make it first-to-market with the key product or service that industry players would need to thrive.

Acting quickly to take advantage of this extraordinary market pull was Destiny Organics (Destiny), a long-time B.C. based supplier of organic soils and growth nutrients to the medical marijuana industry. Recognizing that central Alberta and Edmonton were quickly emerging as a hub for this new growth industry, Destiny chose to build their new state-of-the-art headquarters and central facilities in Nisku, near the Edmonton International Airport, amongst already significant industry grow operations like Aurora, Canna, and Canopy. The new facility would consist of several operations in multiple buildings: company headquarters, a variety of research laboratories, an extraction laboratory, and indoor and greenhouse flower rooms. Most significantly for Arrow Engineering, however, was the 90,000 sq. foot fertilizer and soil production facility and warehouse. This unique facility was to be designed and built to create a productive home for worms. These worms were "farmed" (hence the nick-name for the project – "The Worm Farm") for the purpose of generating worm casings, an important component of Destiny's line of organic-, pesticide- and chemical-free soils, soil nutrients, and other growth media for cannabis production. The facility would also include the sophisticated equipment necessary to process and package the soil products produced. Design and construction of two further buildings, one for warehouse space and one for cannabis research facilities, are still in the early stages.

With a site selected for the facility, work began on the project in April of 2018. From the start it was a race against time to design, execute and complete the facility in order to meet the owner's aggressive timeline for ground-floor participation in the new industry. The work was finished in late March / early April of 2019, on time and within budget. Value of the final project was just over $12,500,00. On time and within budget was an extraordinary accomplishment, given the significant number of pivots and modifications that the Arrow team, working in conjunction with General Contractor Synergy – who requested that Arrow be included as consulting engineers – encountered in the course of the project. Arrow had previously provided

some pre-award support to Synergy in order to help them secure the project, so they were well placed to collaborate and achieve success.

Arrow's specific mandate was to provide electrical, mechanical and civil engineering consultation and design services to integrate the various systems within the facility. These were the systems that maintained a stable and hospitable environment for the worms, as well as supporting the specialized processing equipment for the fertilizer and soil composites, a number of pieces of which were imported from Europe, as they could only be sourced there. These systems included the power grid, in-floor heating, ventilation and lighting, as well as standard operations equipment common to a 90,000 square foot facility.

Although much of the facility's shell itself was pre-engineered and posed little challenge (another large light industrial warehouse south of Edmonton), the devil was in the details – integrating the various internal systems in order to realize the system specifications that the owners intended. Unfortunately, these specifications were often a moving target. The size and purpose of the facility rendered it unique. As such, no one in Alberta had ever attempted to build this kind of highly specialized soil processing facility at this large a scale. The owners had minimal experience with such a design and build project or scaling the specification of their previous small-scale systems for such a large-scale facility.

Thus, the inherent challenges of the project, as they emerged, demanded both technical innovations to accommodate the specialized equipment and processes; as well as a highly resourceful and interactive project management and design approach that could flex to integrate the demands of the different teams working on the project. What would normally have been a two-step design-build approach became a process of designing during the construction process. Given the accelerated timeline and the significant increase in the scale of the facility the Arrow team, at times, were faced with uncertain specifications. This required Arrow's design team to educate the owners as to how the systems interacted as a precursor to determining the actual design.

Among the significant challenges that demanded innovative responses were the following:

1) As noted above, the highly compressed time frame demanded overlapping processes of engineering design and execution. The owners were not able to finalize some design elements until well into the middle of the project. As such there were constant pivots to accommodate unanticipated modifications.

2) Also noted above, Destiny had never attempted a project of this size. Their previous operations were modest – the scale of this facility was unprecedented to them and for the industry, particularly given the unique requirements to meet the elevated organic standards that the owners had targeted. For example, the facility required sophisticated temperature controls to maintain an optimal environment for the worms' habitat: in-floor heating to keep the worms warm during the cold Alberta winters; as well as; the later addition of a cooling system for the warmer months. Though not unusual, in-floor heating was a novel feature for a building of this size. Arrow's mechanical team also designed a water connection system to attach to misting nozzles that were required to control the soil moisture levels.

3) Given that Licensed Producers (LPs) within the cannabis industry are highly regulated as to conditions and inputs for grow operations, the facility outputs (various soil types and growth media) had to reflect these compliance standards. Provision of best-in-class soil, fertilizer and clean, non-synthetic growth media is one of Destiny's strongest value propositions as a supplier to the industry LPs, the design specifications had to support this.
Again, in the cannabis sector, as with every new industry, so many best practices are being discovered as they are executed. Many of these systems had simply never been integrated before at a scale of this magnitude, so many of the design elements that supported systems integration were novel, within the context of their specific application for the industry.

4) Much of the equipment was state-of-the-art specialized equipment from Europe and presented problems aligning with local electrical systems. The owners themselves had ordered the equipment with production goals in mind, not implementation specifications, and were unfamiliar with some of the baseline requirements for electrical system design and installation.

5) The contents of the building presented unique challenges insofar as the soil and the soil processing equipment generated large amounts of dust. To contain these particulates and keep them from contaminating sensitive equipment and troubling the operators, the Arrow mechanical team designed an elaborate dirt and dust control system with the help of an industrial sheet metal specialist. Electrical equipment needed to have high levels of dust-resistance, with all enclosures rated for protection against particulate contamination. Lighting and ventilation systems needed to perform under exceptionally dusty conditions. Further, the ventilation system itself was designed to serve different occupancy needs. In addition to the worm habitat and soil preparation, office space was also needed for the administration and operations personnel. Hence, a multi-functional ventilation system emerged as a requirement.

6) The “Worm Farm” produced more than one type of soil. Since there are several different types of soil and growth media that are produced in the facility, the different soil types needed to be segregated throughout the cultivation of the soil, as well as during processing.

Throughout the project, the overriding challenge was one of fully integrating each of the above sub-challenges in such a way as to bring the entire project to fruition in a timely manner and within budget for the client. As noted above, the Arrow team was often working on design elements in tandem with installation contractors and other local service providers, as well as the owners. Helping to educate the owners and coaching them through difficult decision sequences simply in order to finalize specific designs to inform the contractors, was a frequent occurrence throughout the the course of the project. Functioning as not only a Project Management and Design team, but as a Project Integrator and Owner Educator, forced the Arrow team to rethink their own interdisciplinary practice to find new ways to respond and realize an effective solution.

Systems Integration as a Design Mandate

While Arrow Engineering was, technically, only responsible for the basic mechanical and electrical system design of the facility, in order to fulfill their mandate, the Arrow team needed to rise to the challenge of integrating the ongoing changes that touched many of the facility’s systems as they were selected, designed, and implemented. This led to significant interdisciplinary problem solving on the fly, including pivots and problem resolution at top speed for numerous mechanical and electrical engineering challenges during the actual course of implementation.

Team members found themselves working with equipment vendors from Europe to problem solve installation and calibration issues raised by different specifications. Arrow personnel joined the owners for calls with diverse equipment providers and contractors from yet other parts of the world who had more experience with related processes to provide technical details about the facility and to help the owners make informed decisions. This allowed Arrow’s engineers to integrate elements of the processing equipment and resolve the mechanical and electrical engineering issues. In order to integrate the worm habitat and soil component processing systems that produced the final soil products, the Arrow team was in regular dialogue with the owners, consulting as to the baseline system requirements necessary to support the technical aspects of soil-building and Phyto-nutrient processing. The support and education of the

owner's team was ongoing throughout the project, with Arrow helping to apply their product expertise to the design and construction of the building.

In so many cases, preliminary consulting to resolve a design issue happened as the design was being developed; the time constraints imposed by the aggressive construction timeline required it. Since the owners were unfamiliar with some of the technical requirements demanded by the installed systems for such a large scale facility, the design process included a significant educational component throughout the course of the project. Arrow engineers worked closely with Destiny leadership to help them understand the nature and rationale behind the design decisions as they were being discussed and executed so that all parties understood the whys that informed the design.

Energy Modeling as a Cost-Saver

Since the Arrow design team was responsible for the overall integration of the electrical and mechanical systems, responsibility for compliance among all the electrical and mechanical systems was in their portfolio. Early in the project the Arrow team advocated for an Energy Modeling (EM) approach to ensuring NECB compliance through the performance path for the electrical and mechanical system, rather than a prescriptive path to compliance resolution for electrical and mechanical sub-systems. Although this presented a more expensive scoping process initially, the decision was ultimately a cost-saver for the project, as the building was assessed as a unit, rather than system by system.

Although the design of the building envelope was outside of Arrow's scope, using energy modeling and the performance path to demonstrate NECB compliance allowed for cost optimization of the building envelope design and the opportunity to further reduce cost to the project.

Interdisciplinary Coordination Saves Time

The Destiny project was completed on time and within budget. As noted, this was a feat, given the numerous rounds of modifications and changes to design elements that were requested throughout the project. Arrow's fundamental organizational commitment to a problem-solving approach enabled the team to address these changes as a matter of course and respond accordingly. By adopting a flexible, client-centric approach, Arrow was able to work through the changes as they emerged; supporting the owners, the general contractor, Synergy, as well as with the numerous sub-contractors on site.

Arrow Engineering's internal culture of critical engagement enabled them to respond positively to the unusually high level of large- and small-scale changes, attending to the process of resolving issues with a client-centred, service-based approach. This success contrasts with a defensive and proprietary approach to revisions that could have resulted in detrimental delays, that would have negatively impacted the project as well as soured ongoing relations with clients and other contractors.

Ultimately, Arrow achieved one of the most important goals of any service provider in any business: a satisfied client, happy with the work that was done and the project as it was completed. As noted by Taylor Inglis, President and COO of Destiny Organics: "Working with Arrow Engineering was a great experience. They took the time to understand the needs of the project and worked collaboratively with the entire design team to ensure the project was a success. Arrow went above and beyond standard protocols to guarantee the satisfaction of all stakeholders."

Lessons Learned and Re-applied

Among the significant positive outcomes of the Worm Farm project was the learning that the Arrow team experienced as a by-product of spending time in an educational stance with the client. These lessons will be directly applicable to subsequent projects and have prompted other customer-centric process improvements in development. Accordingly, with future projects, Arrow will be ready with a toolbox to help prospective clients help the design team to define the project parameters. Process improvements will include initiatives such as:

1. More stringent pre-project interviews with a prospective client to determine not only the specifications of the project, but the level of familiarity or experience that the client has regarding the details, priorities and sequential processes of such a design and build project.

2. Active discussion ahead of time regarding systems and equipment that need to be integrated as a matter of completing project requirements. This is particularly important when working with new kinds of facilities in new sectors, such as the cannabis sector.

3. Amplifying the above, enhanced preliminary engagement with the client encouraged Arrow to introduce an updated questionnaire to be completed by new potential clients ahead of the project to determine any red flags: identifying what important planning pieces are missing and/or are uncertain as a preliminary step before fully engaging in the detailed design phase of the project. Issues such as an accelerated timeline, specialized equipment with special implementation needs, and ambiguous specifications for specific processes would all be sorted out ahead of time, enabling a more consistent work flow during the actual design and construction phases.

All the above will contribute to an essential upgrade of the preliminary engagement processes with the client and other stakeholders. Any steps that can be taken to minimize ambiguity and maximize the clarity of the process will be helpful. As with the Energy Modelling approach to the NECB requirements, the scoping of the project may have been more detailed and time and cost intensive out of the gate. This saved all parties time, money and effort in the long run.

Client Satisfaction Key Criteria of Success

In the end, the Destiny facility, a.k.a. the Worm Farm, was a success! The client, as represented by President and COO Taylor Inglis' comment above, was happy with the outcome and expressed strong positive support for the Arrow team. Arrow's successful efforts reflected positively on Lead Contractor Synergy as well, earning Synergy more work in the process. This, of course, helped the Arrow team earn the respect of Synergy over the course of the project, as they saw that Arrow was responsive and integrated in their problem-solving approach. Synergy has since expressed interest in working with the team on upcoming projects. The architect,

Planworks, has also recognized the strong, integrative work that Arrow provided for the project.

Arrow was called upon to design a versatile system that would handle upgrades and as-yet-unspecified-improvements for a specialized client in a dynamic industry with parameters that are defined by a sense of possibility (and tight regulations) rather than concrete, established operational processes. In the face of significant design revisions and process modifications, Arrow still brought the project in on time and within the design budget. The need for problem solving in process rendered the typical two-step design and construct building model irrelevant, forcing the team to engineer systems in the absence of critical specifications.

The client, the contractor and other stakeholders and participants were impressed by the Arrow team's resourceful performance and execution under duress. Arrow provided exceptional service, delivering a fully-realized project on a compressed timeline within the cost parameters assigned to them, adjusting and revising their designs throughout to accommodate the changes needed by the owners. In the process they, and the owners, will have gained the advantage of more refined approaches to future projects.