Evolution in geosynthetics starts with utilizing data technology

Gregory Pignataro[1] and Evan Bao[2]

[1] GeoCAAB and COMANCO. E-mail: GPignataro@geocaab.com
[2] GeoCAAB and COMANCO. E-mail: EBao@geocaab.com

ABSTRACT

This paper focuses on automating the QA/QC process of geosynthetics installations by way of software integration in the field, data entry and office data management. Technology is essential to the advancement of geosynthetic installations, especially data application. In its most basic form, data application is a means of gathering, storing, and utilizing information more easily than its predecessor(s). If implemented appropriately, data application technology improves process efficiency and in turn industrial products. Users and downstream stakeholders of process improvements can then capitalize by delivering quicker, higher-quality, more economical products results The geosynthetics industry is lagging in the area of data application. From a feasibility perspective and assessing practical implementation opportunities, many means and methods widely used for tracking geosynthetic installations are antiquated and, furthermore, lack reliable authenticity verification. The current accountability requirements require a robust catalog of information reporting to substantiate this important environmental construction practice. The combination of room to evolve in practice and existing data requirements make the geosynthetics industry an ideal suitor for technology integration. While advancements in materials manufacturing, welding equipment, and post-installation leak surveys already contribute to progress, there is a lack of universally accepted information infrastructure to aggregate all facets of an installation. Software automation at the field level allows for a cyclical geosynthetics ecosystem that benefits the industry as a whole.

INTRODUCTION

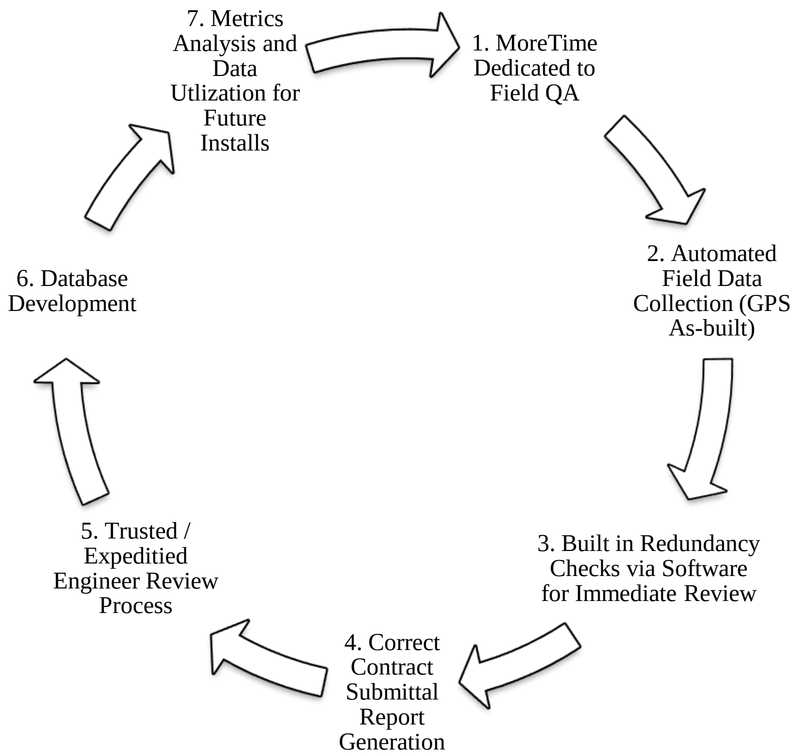
In the context of geosynthetics installations, QA/QC stands for Quality Assurance (QA) and Quality Control (QC). These processes are crucial to ensure that the installation meets the required standards and specifications set forth by site specific engineering. The QA/QC process of geosynthetic installations is the logical starting point for data technology and automation as it performs three key functions when automated.

First, it improves physical field quality assurance (QA), which produces geosynthetics installations with greater focus on assuring that the services meet the regulatory requirements of each project rather than just collecting data.

Second, automation expedites the review and reporting quality control (QC) by built-in analysis algorithms.

Third, a technology infrastructure creates a centralized database that leverages past installation information and supplements experience with different materials and applications throughout the industry (Ramsey 2019).

These general principles will be examined more in-depth and evolve in the following paragraphs. The cyclical nature of improved QA/QC is illustrated in Figure 1 below.



AUTOMATED FIELD DATA COLLECTION

Geosynthetics by nature (i.e., typical industry specifications derived from GSI and ASTM Standards) require a large amount of redundancy when it comes to proper deployment and seaming. These practices must be performed meticulously (QA) and then documented (QC). Typically, these duties are completed by an installer's individual QA/QC technician and verified by an on-site 3rd party owner representative commonly referred to as construction quality assurance (CQA) individual. There are more specifications within a geosynthetic system regarding subgrade conditions, cover soil placements, and more. The focus of this paper is the data associated with geosynthetics deployment and seaming. However, there are boundless opportunities to integrate the ancillary components (subgrade condition, cover soil placement, etc.) of a geosynthetics installation system when a software infrastructure has been established.

Currently, the industry handwrites or uses a simple digitized form to collect QA/QC documentation. This is hard to comprehend in 2024 considering the magnitude of legitimate QA needed for this craft and associated documentation required on a per-acre basis by installer QA/QC technician and 3rd Party CQA (Koerner 2012). There are two main identifiable liabilities with this current practice. The first is that it takes significant time and manpower for document upkeep, such as as-built drawings panel placements, roll number, roll deployment, trial welds, destructive sample testing, seam information, and repair information. The real value from a QA/QC Technician and 3rd party CQA is within the QA portion. Their roles should lean heavily on physical inspection of the geosynthetic installation for quality workmanship, not necessarily just the documentation (Toepfer 2016). The documentation can be perfect, but if the systems fail due to improper workmanship that went unaddressed during construction because QA efforts were limited due to the QC effort, project stakeholders are still at risk. The second is that manual documentation allows for greater chance of human error and information fabrication/manipulation. Conforming QA/QC data collection and increasing the speed of data collection and analysis for the day-to-day field documentation will directly enhance the quality of geosynthetic installations.

Based on these observed areas of improvement to means and methods, automation must be applied to each section of required QC to address data collection speed and reliability. This automation begins with as-built generation. Hand sketched, scaled drawings that include all pertinent panel information are extremely labor-intensive to complete, and information can easily be missed. If information is missed during the as-built phase, ripple effects on seam and repair info will also go unnoticed. An existing step in the right direction is the seldom-seen “GPS As-built” specification requirement. Anyone with GPS equipment can shoot points at each panel intersection and grade break. Once that is completed in the field, the points file can eventually become a GPS coordinated as-built once they are connected by a program such as AutoCAD or similar. However, to populate this “GPS As-built,” a reference hand drawing is likely needed for location reference. This includes panel numbering, roll assignment, repair and destruct locations, and terminations. Therefore, simple “GPS As-built” within these limited parameters does not address speed but addresses reliable future use. With no speed improvement, QA/QC technicians cannot shift that time allocation to physical QA, which is the more valuable time commitment.

A more encompassing improvement to the As-built portion of QA/QC, and in turn, other downstream information collection practices, would be universal use of "*automated* GPS As-built" generation. Computer software can automatically generate the linework, panel, repair, and destruct numbering and termination call-outs without handwriting or using another software to connect the dots and annotate manually. By merely assigning descriptor attributes, such as panel numbers and repair numbers, to the GPS points during collection, the software algorithm associates like descriptions and locations to automatically create the liner system as-built in real space, incorporating other system details such as repair locations, destruct locations, and termination references. This allows field techs to quickly see the as-built evolve in the field to address any missing information or shots in real-time. This approach allows for more time inspecting the seams, assessing changing in-situ conditions, examining proper heat seal and grinding techniques, all of which are directly tied to improving the installation quality and ensuring the liner system's long-term sustainability. Finally, using the automation software platform in practice, these field documents can also be uploaded via cloud technology, so office personnel or clients may see this information in real-time. This functionality can be used as another set of eyes for checking information, specification adherence, real installed quantity verification, material inventory and more.

BUILT IN RECORD KEEPING AND REAL-TIME CQA

Remembering automated GPS as-built is the foundation for an improved system; the abundance of metadata within the as-built can be used to populate the other QC specification requirements. The software knows every panel intersection, the locations of every repair and destruct, terminations, panel placement square footage reports, seam and repair information. This embedded data within the as-built generation phase is used to automatically generate the other required QA/QC submittal requirements. This workflow makes sure that every piece of info on the repair and seam reports is in line with what is on the as-built and, most importantly, within project specification. Currently, the typical process is to walk the liner physically, hand draw the as-built, then once again walk the liner to populate every line of seam control and repair reporting on their separate respective report sheets. Using a field tablet or similar technology, automated GPS as-built offers the opportunity to shoot points and attribute those points once. Welding and testing information can then be filled in on the already generated lines. Automation eliminates the need to collect the same information multiple times and eliminates paper recordkeeping.

To further improve efficiency, it is essential to acknowledge that some information does need to be "filled in," requiring the tech to read the information on the liner itself. These parameters are set up prior to the job so that he/she is not repeatedly writing the same information, once again saving time. These "fill in" areas on the seam and repair reports are replaced with dropdowns accompanied by other pre-set conditions. One example of those pre-set conditions is air test information input. With software, the technician will utilize a pre-set drop down for the initial start time only, and the end time will automatically populate based on job specification, typically five minutes later. See the example screenshot below in Figure 2.

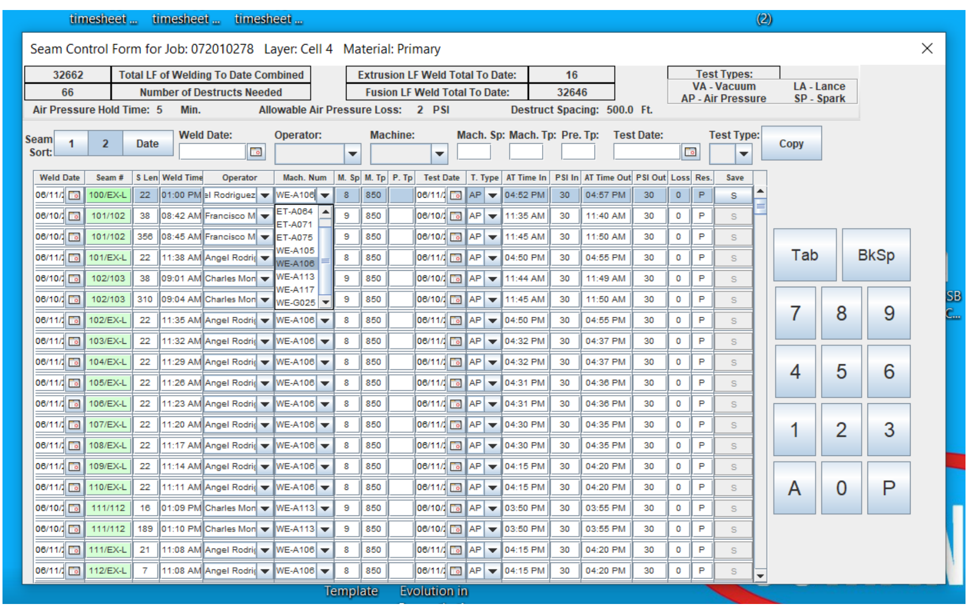


Fig 2. Populated Seam Control Example. Hundreds of lines auto populated from automated GPS as-built**.**

Currently, the industry relies on thorough contractor QA/QC technicians, persistent site CQA's, and post-project data review by engineers to capture all this information. But do we really know the QC data submittals are correct per project specification during and at the completion of the project? Initiating redundant software assistance benefits owner representative CQA as well. To some extent, the software can do the job of a CQA from a documentation standpoint by cross-referencing all of this data with the appropriate previously defined specification. For example, when a line of seam control or repair reporting is completed, a check function automatically makes sure the information is in line with the appropriate pre-weld information. This real-time inspection principle provides unique advantages in terms of speed of work and reassurances to the CQA team that everything is completed and documented, prior to being covered by a subsequent layer in the lining system. If incorrect or missing data is identified, it may be too late to confirm or verify the information because another layer may cover the materials in question.

It is important to recognize that other solutions have been developed with similar features; specifically, Glen Toepfer's Supertek and Geo-X's 'Geo-Q' platforms.

REPORT GENERATION

Foundational improvements to QA/QC field means and methods have made the physical data collection faster, less strenuous, and more authentic for field personnel. It has also been recognized that automated QA/QC software integration provides real-time project updates via a cloud platform for other stakeholders in geosynthetic installation projects to monitor progress.

Because all parties within the field setting are working more effectively, the final phase of an install relating to submittals is now more easily developed. Again, comparing to the current state of practices, multiple sheets of paper or, at best, excel documents typically need to be compiled, put into a clean format, and printed in a legible manner for professional submission. This process requires an additional meticulous individual (usually a corporate QA/QC Engineer or similar) by the installation contractor to make sure every piece of info is accounted for. Once submitted, this process must be essentially repeated by the project's engineer of record. QA/QC software provides solutions to this sequence of events.

By having a centralized program, users may "print" submittals upon completion. Furthermore, as examined previously, the process of checking accuracy is an on-going effort within the software. Therefore, once the final panel, seam, repair, or other is documented with automated GPS as-built and ran through QA/QC software, the reports can be trusted for accuracy. This process substantially decreases the time allocation needed for report review and submission post-installation. On a per 20-acre basis, this type of systematic field approach results in up to a 97%-time reduction requirement during the data compilation and review process. (CQA Solutions 2014) Conservatively, a 20-acre installation's final package, including as-built drawing, can be completed in an 8-hour workday.

DATA BASE DEVELOPMENT AND LEVERAGING

At the completion of a geosynthetics installation, contractors and engineers are left with a vast amount of data and information. Previously, this info would not be used post project completion. At most, installers keep track of their destructive test failure rate as a general industry parameter to track a company's quality. But there is much more in-depth analysis that can be made with a metrics analysis tool. Some parameters which are valuable for installers, engineers, and owners include:

- Field Pre-weld Pass/Fail Rate
- Field Destruct Pass/Fail Rate
- Laboratory Destruct Pass/Fail Rate
- Linear Feet Welded – Extrusion
- Linear Feet Welded – Fusion
- Square Foot Deployed
- Repairs by Type (How many repairs are caused by burning out, losing laps, etc.)
- Waste Percentages (how well a company utilizes material)

All of which can then be filtered by:

- Date Range (time of year)
- Material
- Welding Technician
- Welding Equipment Used
- Superintendent
- Job Site
- Client
- Design Engineer

A combination of these metrics provides far more comprehensive picture of a project's success above and beyond simple Pass/Fail percentages.

The modern generation of successful companies and workforces are data driven. Every industry in the world is optimizing data collection to be able to leverage its operating efficiency. Accurate, centralized data management software benefits installers, engineers, owners, manufacturers, and other stakeholders in the geosynthetics industry. Up until now, tangible improvements to field and reporting under the QA/QC umbrella have been addressed. But in addition to these baseline improvements, there are more widespread advantages downstream that can recirculate to an improved next project.

Some examples include targeted internal training by installers if trends are seen with specific employees not performing well or a specific material is continually underperforming. Legitimate résumé generation during pre-construction submittals for owners and engineers. Other miscellaneous data optimization examples include reductions in billing conflicts (Geo-X 2020) and advantages going into prospect cell or cover construction projects. Tie-in points are known for the existing cell or covered area; cut and fill plans are easily and accurately adopted from a known boundary previously established from the as-built GPS locations.

While advancements in materials manufacturing (better additives, taped seams, conductive backed materials), welding equipment (data acquisition fusion welders), post-install leak detection (leak integrity testing), and existing "justified quality management systems" (Koerner 2012) are already contributing greatly to the advancement of geosynthetics, a QA/QC software platform is needed to substantiate and document the effectiveness of these tangential advances. Show how these other stewards of the industry improved failure rates. Record the data that informed the material selection process for the right application. Right now, these metrics are stored within the heads of those who performed on these specific projects. The data application democratizes the information for rapid decision making, promoting time devoted to the most important aspect of the project, construction of a quality installation that best serves its intended purpose.

CONCLUSION

The roadblock for universal acceptance of QA/QC software use seems to be that the industry, built around the regulatory agencies that govern permittance of a lined facility's use, does not require efficient authenticity like other industries. Furthermore, any previous attempts to fill the gaps within the current process did not approach the remedy holistically. To truly improve the work flow of a geosynthetic lined system, and final product, the solution must start in the field, seamlessly translate to office reporting, and produce a robust, leverageable data warehouse to be used for continued improvements. This cyclical model results in cost savings for multiple stakeholders involved in a venture utilizing this technology.

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