
# GeoCue and Project Dashboard

## - A New Approach to Geospatial Process Management

A GeoCue Whitepaper

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***Executive Summary:***

We work closely with companies and government agencies that perform geospatial production as either their livelihood or their core mission. The number one complaint that we hear from Executive Management is:

> "I never really know the status of the projects being worked by my teams. Sure, they give me weekly, detailed reports but nothing ever seems to deliver on time or within budget. Most vexing is that I never become aware of problems until they are past the critical point. Every tool that we have deployed to date to fix this problem I would have to assess as a failure. I cannot see us reaching new levels of expertise and productivity until we can consistently perform our mission in budget and on time."

We have just released ***GeoCue Project Dashboard***, a completely new way of monitoring geospatial production. This tool, combined with our existing set of process management applications, will allow you to monitor the critical aspects of all of your projects using a web browser on your laptop from any location.

This set of technology is not simply a new web tool to view projects. It represents a new philosophy of project management specifically geared toward situations in which a large number of geospatial entities are processed through a series of steps and aggregate to form deliveries.

We firmly believe that combining our production philosophy of automating the tracking of the micro aspects of projects using GeoCue Client and aggregating these pieces into Project Dashboard will provide an immediate positive return on investment and significantly improve project quality and profitability.

***Introduction:***

For over five years now GeoCue Corporation has been developing geospatial workflow framework solutions. Our focus has always been on making workflows more accurate and efficient with goals of improving throughput while simultaneously improving product quality. During deployments with a wide range of clients, we have had the opportunity to observe quite a few techniques of project monitoring and tracking. We have used these observations to motivate the design of a new approach to geospatial project management that we believe shows the promise of making a step improvement in project profitability.

***What is Project Management, anyway?:***

There are many formal definitions for this as promoted by organizations such as the Program Management Institute (www.pmi.org). However, we all have a pretty good notion of what we are trying to achieve without delving into the dictionary. We want to manage our project such that we achieve some basic results:

- Proper scoping of projects (base-lining)
- Completion of the project on or under the baseline schedule
- Completion of the project on or under the baseline budget
- Project Quality exceeding customer expectation to the point that zero rework is required

We would like to accomplish the above without the need to constantly rely on heroic efforts of our core dedicated staff mere days before the big delivery is due.

***Observations of the State of Art:***

The range of techniques used in managing projects[1] in the real world is much more limited than one might guess. In most project management systems that we have encountered, Microsoft Excel plays the central role. The primary support tool for the spreadsheet is email. The level of detail varies widely from company to company. Some track only at a high level (say project blocks) whereas others track at incredible levels of minute detail. Generally, we can say the following about current systems:

- They are generally updated after the fact
- Surprisingly, they tend to be very insular
- They are generally not very accurate
- Most significantly, they are reactionary instruments

So we find most projects being managed using out of date Excel spreadsheets in a reporting rather than forecasting way.

What about tools such as Microsoft Project (and similar purpose built project management software)? We sometimes see these tools used for initially configuring projects or for preparing monthly reports. We very seldom see them used for active project management. Why? In a nutshell, the effort that is required to keep these tools up to date is not perceived to be worth the benefit of the output of the tool. More importantly, they do not easily accommodate the *aggregation* of objects into a consolidated status (e.g. what is the summary status of 2,467 ortho images for the initial QC step?).

[1] Our entire discussion is limited to geospatial production projects

### *How Can We Successfully Manage Geospatial Projects?*

We believe that the key to successful project management is similar to that of successful quality management – it must be built-in and it must provide information that can modify the process. For example, in a factory QC system we might statistically measure the principal diameter of a widget. If it exceeds a specified tolerance, we would perform corrective action on the machinery or process that determines widget principal diameter. We would then expect our QC measurement process to reflect the correction. If our measurement were occurring automatically and triggered a notification immediately upon exceeding the tolerance, very few widgets would require rework. This approach to Quality Management is very, very basic and we all fully understand the principles. We think we just need to apply these same approaches to managing projects. The steps are basically:

- Instrument critical processes such that measurements are automatically collected
- Monitor instrument outputs
- Analyze data
- Act appropriately on analysis

We can compare the very simple diameter example to actual project management (Table 1):

**Table 1: Factory/Production Analogs**

| *Management Action* | *Factory Example* | *Geospatial Process Management Analog* |
|---|---|---|
| **Define the baseline** | What is the acceptable range of diameter for the widget? | What is the acceptable range of time for editing a tile of data? |
| **Instrument** | Install a Coordinate Measurement Machine to monitor diameter | Install a process that *automatically* measures time to edit a tile |
| **Monitor** | Send a notification when the diameter is out of tolerance[2] | Send a notification when edit Variance exceeds a threshold |
| **Analyze** | Diagnose the cutting machine | Perform root cause analysis |
| **Action** | Take corrective action | Take corrective action |

In the following sections we will lay out how we think these steps can be successfully performed for managing projects.

### *Define the Baseline:*

You cannot determine if you are successful if you have not defined success! The baseline is:

- Schedule
- Cost
- Definition of Customer Acceptable Products

[2] Of course, this can become as sophisticated as automatically stopping machines and so forth.

In most cases, all three of these factors are determined during contract negotiations with little opportunity for revision following final award. If you do not have production management in the bid and award negotiation process, you are in trouble prior to even beginning the project! The driving factor is, of course, the definition of what it is that you will deliver under the project. In our experience, most rework is a result of a mismatch between vendor and customer expectation rather than defective contractor work. We have a sad lack of product definition in our industry thus customers do not really understand terms such as "automatic classification only", "machine-placed seam lines", "best available elevation data" and so on. We are not naive either; we are fully aware of the difficulty of being scrupulously detailed at the bid phase yet still winning the contract! Our advice here is to put everything in the contract folder so that your boss won't act surprised when you have to have the project team hand-edit those ortho seam lines!

Even if you do job averaging cost management, you still should model every project in detail when preparing your offer. Therefore, we believe that every project should be estimated in a bottom-up cost buildup. We are fully aware that a detailed estimate of editing thousands of LIDAR tiles cannot be performed manually thus we provide tools within GeoCue to automate this process.

Cost and Schedule are, of course, highly correlated if you are doing all of the work within your own company. They are less correlated if you are subcontracting critical elements of the work on a Firm Fixed Price (FFP) basis. In general, FFP subcontracting reduces direct cost risk but increased schedule risk. We very strongly recommend that you levy our "micro-management" concepts on your subcontractors as a risk mitigation strategy[3]. Obviously your subcontracts should always include carrots (on time bonus) and/or sticks (delay penalty).

### *Define the Roles:*

Successful operations, regardless of their nature, must have very clear bosses and accountability. You need to ensure that when an alarm sounds, a person with very clear accountability responds.

During our surveys of companies and agencies involved in geospatial production, we observed the general roles listed in Table 2. In many instances these roles were not specifically defined but they were put into operational practice. Thus in our descriptions of who does what within the organization, we often refer to these roles.

[3] We provide a comprehensive set of tools for "wiring" your subcontractors into your production management system via our Distributed Project Management System (DPMS) suite of tools.

**Table 2: Project Roles**

| *Role* | *Functions* | *Notes* |
|---|---|---|
| **Executive Management** | • Organizational Strategy<br>• Bid-No bid decisions<br>• Executive level project management | • It is these individuals onto whose carpet the workers are called when the project goes south |
| **Project Manager** | • Bid preparation<br>• Project Definition<br>• Client liaison<br>• Production Manager liaison<br>• Reporting to Executive Management | • Usually has responsibility for multiple project simultaneously<br>• Manages the "macro" aspects of projects |
| **Production (Unit) Manager** | • Manages one or more production "pods" (e.g. LIDAR, Ortho, Flight Ops, etc.)<br>• Usually does workflow setup<br>• Usually performs very technical aspects of a segment of production | • Manages one or more "micro" areas of projects<br>• Usually reports to a Group Production Manager |
| **Project Worker** | • Performs the micro tasks of production | • Reports to a Production Manager |

***Micro Management:***

It is said that a journey of one million steps begins with that first step. A corollary to this is that for the journey to be successfully completed, each of these million steps must be executed successfully.

We believe that a project cannot be successful (e.g. profitable) at the *macro* level if it is not managed at the *micro* level. Additionally, we do not believe that it is practical to manage at the micro level without automatic tools. This is a very important point since tools have simply not existed prior to GeoCue Client for performing management statistics collection automatically.

As an example, consider a large LIDAR processing project that includes steps such as:

- Import LIDAR flight lines[4]
- Create a tiling scheme
- Copy LIDAR data to the tiles
- Perform initial QC

[4] For our example, we are ignoring some important tasks such as geometric correction…

- Apply automatic processing macros
- Edit LIDAR data (e.g. in a tool such as TerraScan)
- Final QC

Some of these tasks can be performed by a single person and are of relatively low risk. An example would be importing the LIDAR flight lines into the project. Other tasks require multiple users and are very interactively intensive. In our example, the highest risk task is "Edit LIDAR data."

The experienced production manager will assign a Budgeted Effort on a per tile basis and closely monitor progress against the budget as the project progresses. Corrective action must be taken very early in the process if the aggregate is to be successful. For example, if 1 hour per square kilometer has been budgeted for LIDAR data editing but the actual effort is averaging 2 hours per $km^2$ then some action must be taken if this phase of the project is to be successful. Examples of actions the Production Manager might take include:

- Check the effectiveness of the automatic classification step – are inadequate filtering algorithms causing more than the anticipated level of editing?
- Are Production Workers "over-editing" the data?
- Are Production Workers lacking in editing skills?
- Is the over-budget occurring with a small group of workers or is it across the board?
- Is the terrain more difficult than budgeted?

Our purpose here is not to provide advice on how to correct specific problems but rather to emphasize the criticality of monitoring progress at the micro level and taking quick corrective actions early in each production phase.

GeoCue provides a number of tools and facilities to assist in the micro management of project data. These tools include:

- Automatic assignment of Budgeted Effort (BE) based on unit area or unit length
- Tools to interactively change BE, in bulk, based on context (e.g. superimpose a tiling scheme over context data and assign more time/unit area to heavily vegetated areas)
- Tools to assign workers to work units
- Automatic recording of process history to include who, when, on what machine, how long the step required, etc.
- Analysis tools to identify problems such as positive Variance or late start dates

These GeoCue tools are used for two separate activities. The first is project estimation. By assigning default values for various tasks (e.g. 0.1 hours per square kilometer for Bare Earth LIDAR editing), simply defining a project will create a roll-up budget (GeoCue Project Dashboard provides the ability to export a complete, rolled-up budget in Excel format). The second use for these tools is, of course, the micro management of tasks as production moves along. Figure 1 depicts a county-wide LIDAR project with the status of processing tiles color-coded to match the checklist steps of the upper right pane.

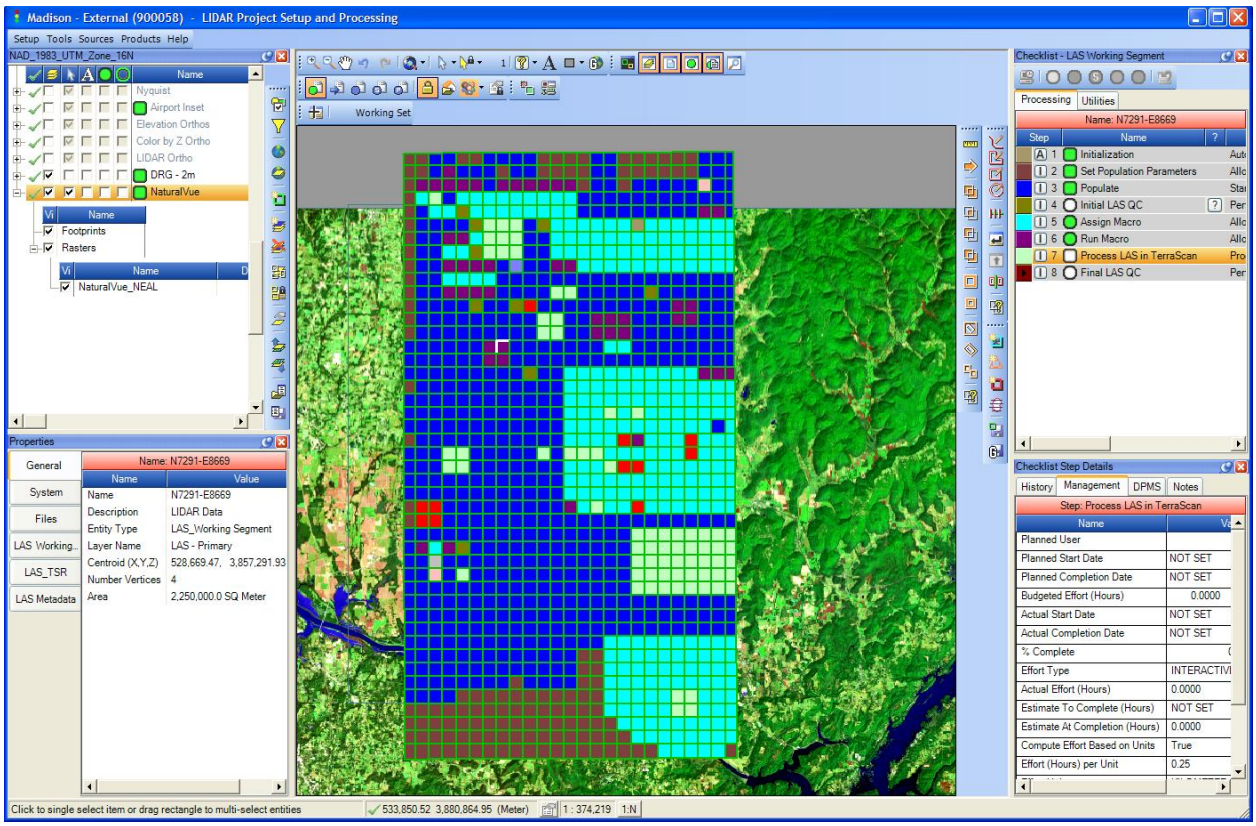


**Figure 1: Processing tiles for a county-wide project**

Note that for each tile in this project (there are 1,125 individual tiles) a Budgeted Effort has been automatically set for each step that the Production Manager deems critical (in this example, Initial QC, Run Macro, Process LAS in TerraScan and Final QC). The statistics for a single tile, "Run Macro" step are depicted in Figure 2. Note some interesting features of these data. A BE has been set of 0.225 hours. This as automatically computed at project definition time based on default values established by the Production Manager (in this case, 0.1 hours per square kilometer). The Manager also set planned start and end times for this step on this tile (in reality, Production Managers seldom plan start and end dates on a per tile basis but instead, set the range for a block of tiles). Note that GeoCue has automatically recorded the actual start and end dates as well as the Actual Effort (AE). From these data, the system has automatically computed the Estimate at Completion and the Variance. Note also the effort type of SYSTEM. GeoCue separately tracks automatic processing time (e.g. Run Macro, Rectify Image) from interactive time (e.g. Edit).

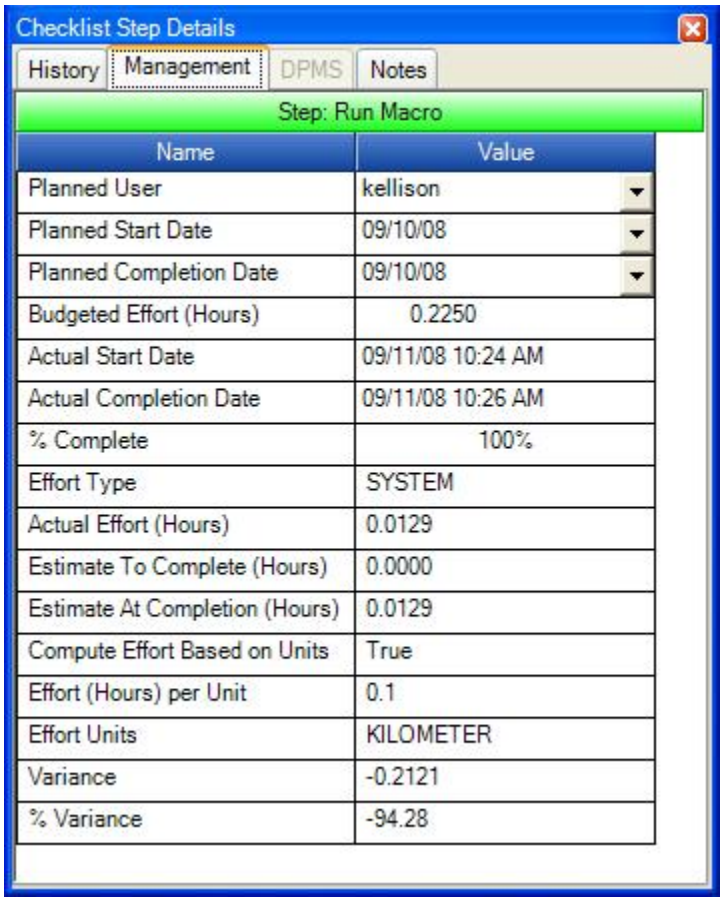


**Figure 2: Management Statistics for a single tile, Run Macro step**

Since the Production Manager has elected to track 4 steps on these tiles, the total number of statistics "packets" being collected is 4,500. All these data are being both initialized and collected automatically.

Collecting these sorts of data using tools such as Excel spreadsheets is not practical. When it is attempted, workers tend to do inputs at the end of the day (or, more usually, when a manager nags them to the point of doing it). By the time the data are input, they are rough order of magnitude guesses. Thus this phase of data collection simply must be automatic if the data are to be at all useful.

### *Macro Management:*

*Macro* management means examining the aggregate of the micro details of the phase of a project. In our LIDAR data editing example, the *micro* management is concerned with the performance on per tile basis whereas the *macro* management is concerned with the aggregate of the tiles. We generally refer to the aggregate as a project *Phase*. For example, the aggregate of the Initial Quality Check step of all of the tiles in a county-wide project might map to an overall Initial QC Phase.

Generally the Production Manager is concerned at the aggregate level to determine if a *micro* level examination of production is needed. The Project Manger and Executive Management will typically always view project status at the macro level and defer to the Production Manager for micro-management issues.

The general items that are examined at the macro level are:

- Did the phase begin on schedule?
- Is the phase currently on schedule?
- Is the current error rate acceptable?
- Is the phase currently at or (preferably!) under budget?

We have just released a new web-based product called GeoCue Project Dashboard for aggregating project information at the macro level and presenting the results in a web-based interface. The idea of aggregation for project management is a new concept that, if done at all in current project management systems, is a manual process. GeoCue Project Dashboard automates the aggregation of *micro* details into *macro* reporting. We think this will be a key feature in moving to a new, more successful level of profit and schedule management.

Figure 3 depicts Project Dashboard with the Edit in TerraScan step of the Madison county-wide LIDAR project selected. The gauge view quickly gives a synopsis of this phase of the project. The Percent Complete (more on this later) shows that this phase is 0% complete. The variance is showing a 4.5 hour positive (overrun) variance. The status icon for the phase (Figure 4) provides a quick overall status of the project phase. In our example, it indicates that there are some tiles in an error state (as indicated by the red upper section of the icon), the phase is In Progress (as indicated by the blue lower section of the icon) and some tiles are in a suspended state (as indicated by the superimposed “S”). An overall view of tile status is visible in the pie chart Entity Status gauge of Figure 3.

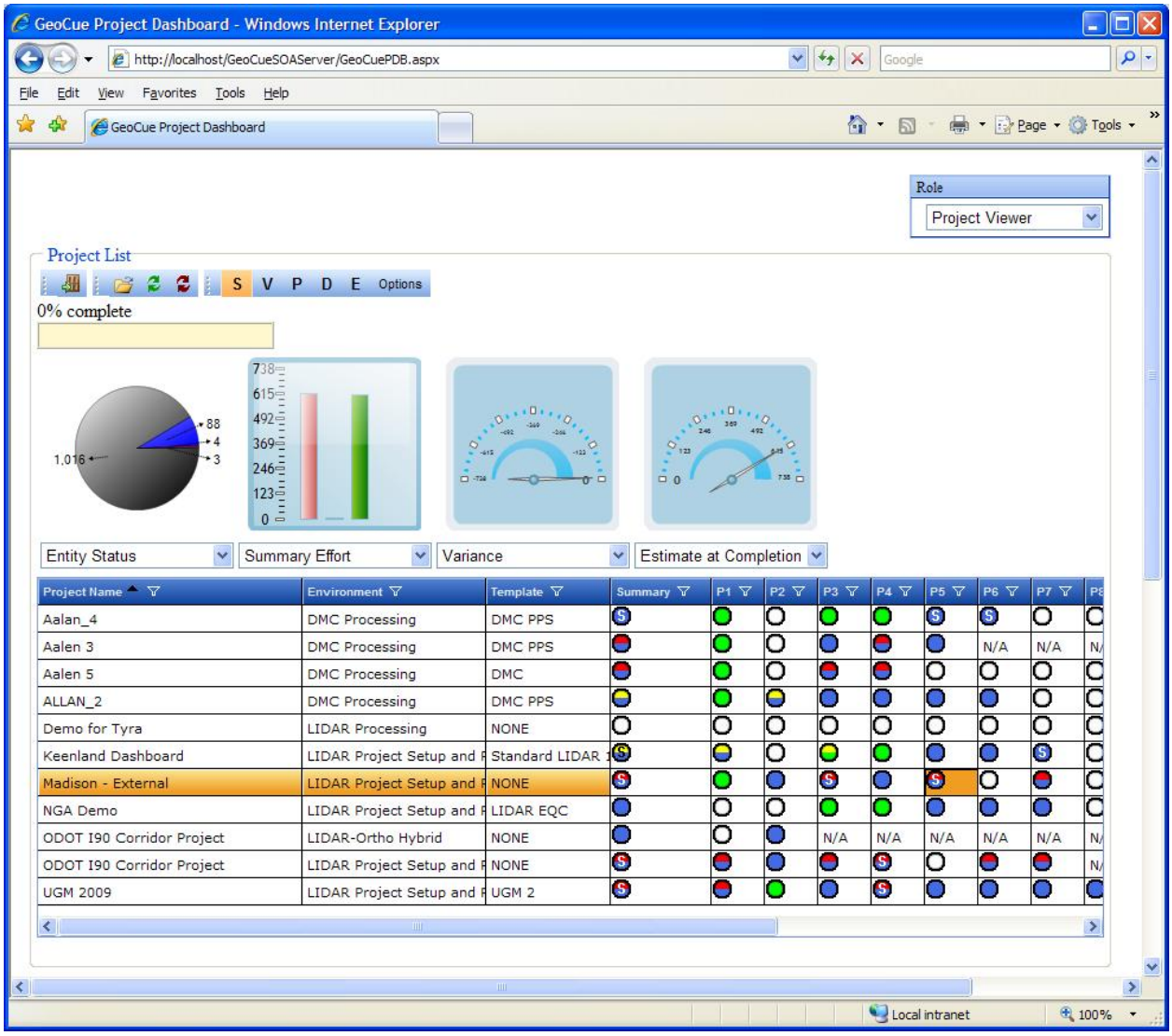


**Figure 3: Project Dashboard showing the Edit in TerraScan step for the Madison project**

**Figure 4: Edit Status icon**

Detailed Phase information is aggregated as well in the lower section of the dialog (Figure 5). Note that the detailed information represents a composite of the individual *entities* that are being aggregated from *linked* information in the GeoCue project. In this case we are looking at the management data for the Edit in TerraScan step.

Phase Name: ***Edit in TerraScan***

Description: Primary editing of all tiles for th

Phase Summary | Financial Info | Linked Info | Layer Details

Interactive:

| Field | Value |
|---|---|
| Planned Start Date | NOT SET |
| Planned Completion Date | NOT SET |
| Actual Start Date | 8/11/2006 |
| Actual Completion Date | NOT SET |
| Phase Manager | bherman |
| Budgeted Effort (BE) | 615.41 |
| Actual Effort (AE) | 4.45 |
| Estimate to Complete (ETC) | 605.87 |
| Estimate At Completion (EAC) | 610.32 |
| Percent Complete | 0.27% |
| Variance (Var) | -5.084 |
| Percent Variance | -0.83% |
| Projected Variance | 1031.905 |

**Figure 5: Detailed Phase information**

An interesting entry to note in Figure 5 is that we provide an *estimate* of the Variance at completion. Since, for individual project items, the variance is zero prior to an item being initiated (since, at this point the Estimate to Complete will equal the Budgeted Effort), the computed variance early in the project phase is not indicative of what it will be when the phase is complete. Thus we use an algorithm (at this point, linear) to estimate the end-of-phase variance based on the current variance weighted by the number of completed items in the phase. This information is critical toward recognizing budget problems early in the phase.

***Enhanced Macro Views:***

The iconic views of project status provide a very quick summary of the status of multiple projects. This iconic view is much easier to digest than the Gantt charts of a Project plan or the tables of an Excel spreadsheet. You can very quickly see the status of each phase of multiple projects in a single view. You can also immediately look at phase details by simple clicking on the phase in Project Dashboard.

However, we quickly realized that viewing the current status of project phases does not provide the immediate information necessary to determine the probability of success. For example, a

Complete phase will have a status icon in Green. The question, however, is not just if the phase is complete but was it on time and under budget?
To allow quick assessment of critical aspects of projects, we added the following viewing modes. Each mode displays its information using quickly assessable icons:

- Standard Mode – Show progress status with errors and warnings (this is the view we have been discussing)
- Variance Mode – Show the Variance of each phase of each project
- Projected Variance Mode – Show the estimated end-of-phase variance
- Schedule – Show how the phase is progressing as compared to the planned phase schedule
- External Financial System – Show a comparison of the actual budget experience on the phase as compared to information from an external financial system (more on this later).

Figure 6 depicts the synoptic status view with Variance Mode selected. Note that the selected phase, Edit in TerraScan, for our county-wide project indicates a negative variance (we are under-budget). However, we can see from the pie chart (upper left of the figure) that only 3 tiles have been completely edited and 88 are In-Progress. This flags us that a closer or different inspection is warranted.

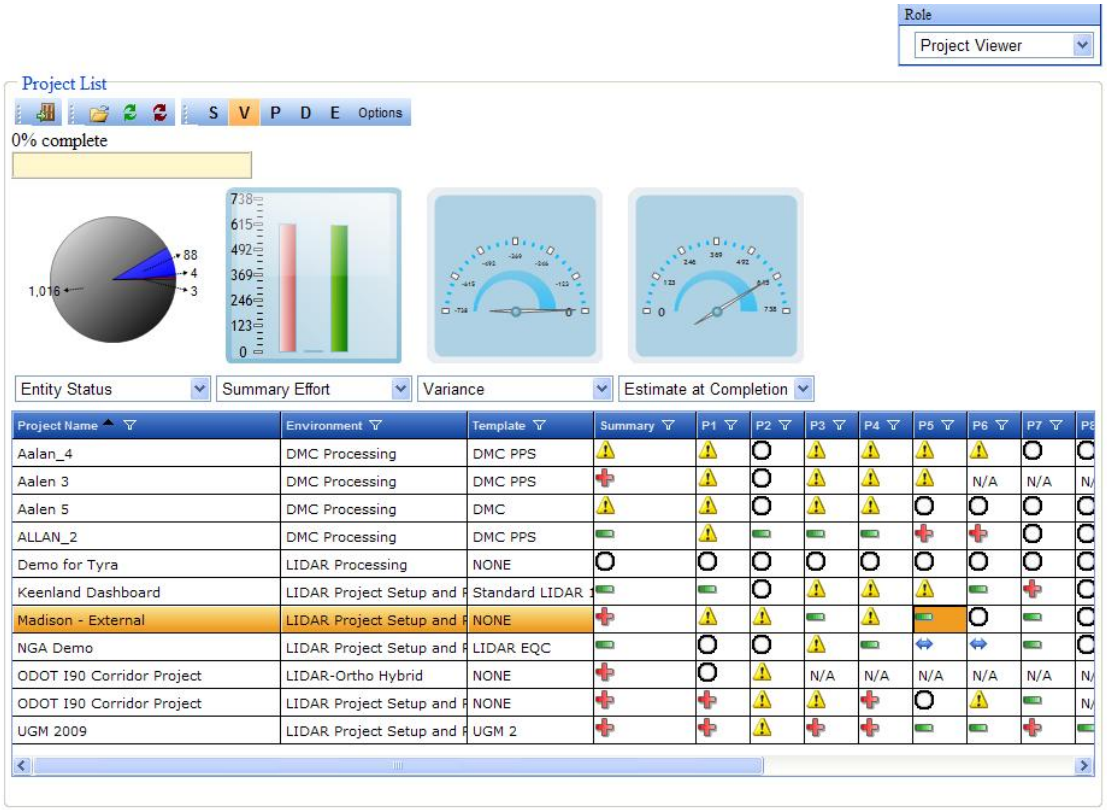


**Figure 6: Project Status - Variance Mode**

We switch to the Projected Variance mode (Figure 7). This mode indicates a projected positive variance for the phase. Note that in this synoptic view, we can immediately see the projected variance for all phases of all projects. Thus we are able to quickly see which phases of projects might be potential sources of budget and/or schedule overrun without the need to examine spreadsheet cells or Project Gantt charts (the triangular warning icons indicate that we have not entered baseline data for these phases).

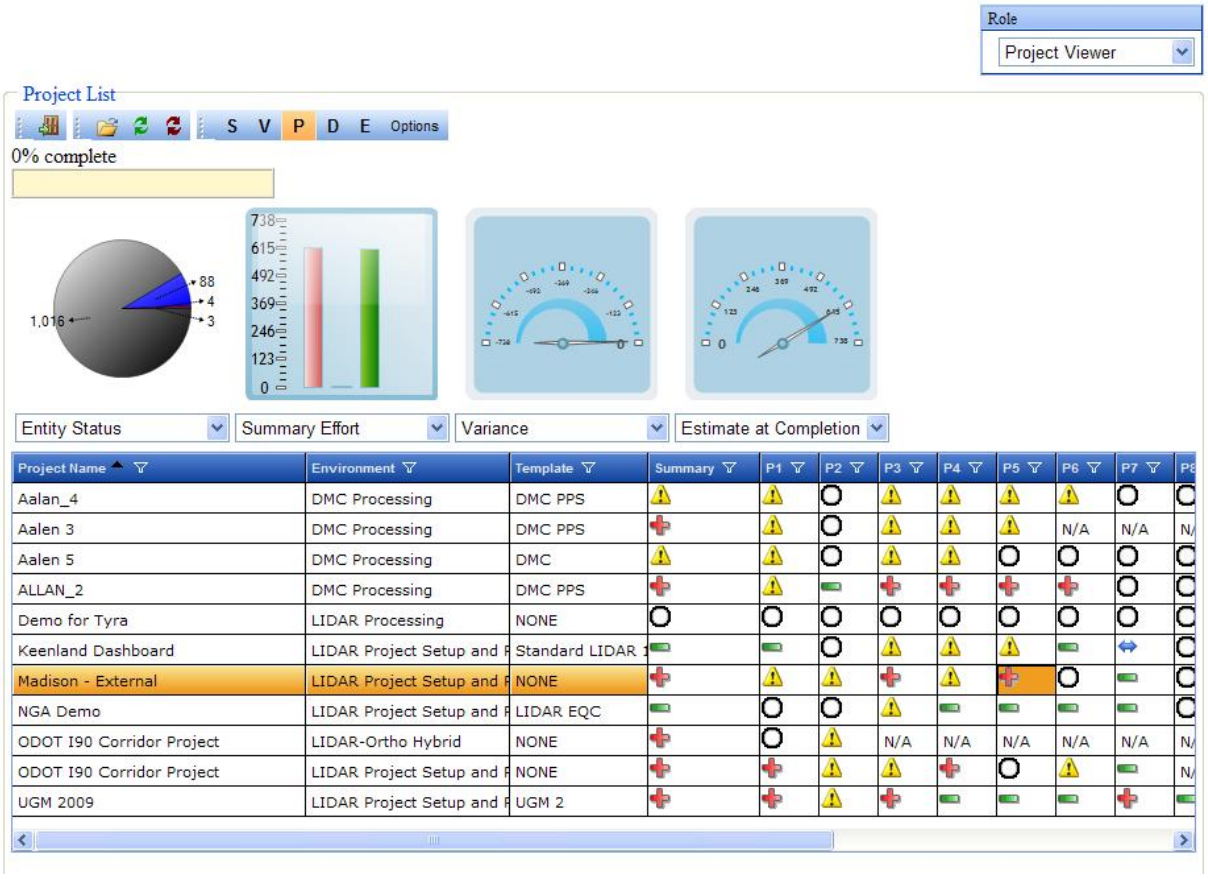


**Figure 7: Project Status - Projected Variance Mode**

Similar quick access views are available for Schedule and External Financial System comparison.

***External Financial Systems:***

When we were designing GeoCue Project Dashboard, we interviewed a number of geospatial production companies to see how project management works in the real world. We discovered that most companies run two sets of tracking numbers. The first is the "golden" set, represented in the corporate financial system (Deltek, Dynamics, BST Enterprise and etc.). Within this system resides the *real* budget for the project, mapped into a set of tasks and subtasks (in fact, the structure of Project Dashboard mirrors that of Deltek project tracking). These budgetary numbers are typically loaded at the time of project award. Time card reports

map labor hours to the tasks and subtasks of this system. Management then uses the comparison of the budget to the actual time card reports to bill the client and to track project status. We refer to these systems as External Financial Systems (EFS).

The second set of data is the *real* project schedules that are maintained by the production and project management teams. These are the schedules to which we have been referring and typically comprise Excel progress sheets and marked off map sheets. These data sets may or may not contain actual labor hours expended on a per-unit basis.

We have often encountered situations where the EFS data are used by Project and Executive management whereas Production Management uses the internal tracking tools. The disconnect, of course, is that the External Financial System data are monitoring profitability of the project whereas the internal systems are monitoring the real progress. It is often the case that the disconnect (e.g. the project is not at the completion level indicated by the EFS) is not realized until late in the project. Often too late, in fact, to take effective corrective actions.

GeoCue Project Dashboard includes a system to track the data in an External Financial System (EFS). In the current release (6.0.x), these data are ingested into Project Dashboard via an Excel Spreadsheet import. In future versions, we plan to directly integrate *read ports* for popular financial systems. We provide two analysis modes for EFS:

- Tabbed summary of a comparison of EFS data to actual production data (Figure 8)
- Iconic view of a comparison of project accumulated hours to those of the EFS

Phase Name: ***Edit in TerraScan***

Phase Summary | Financial Info | Linked Info | Layer Details

| Value | Dashboard | Financial | Difference |
|---|---|---|---|
| BE | 615.41 | 600.00 | -15.41 |
| AE | 4.45 | 24.00 | 19.55 |
| ETC | 605.87 | 576.00 | -29.87 |
| EAC | 610.32 | 600.00 | -10.32 |
| Variance | -5.08 | 0.00 | 5.08 |
| Planned Start Date | NOT SET | NOT SET | N/A |
| Planned Completion Date | NOT SET | NOT SET | N/A |
| Actual Start Date | 8/11/2006 | NOT SET | N/A |
| Actual Completion Date | NOT SET | NOT SET | N/A |

**Figure 8: External Financial Comparison for the Edit in TerraScan Phase**

Figure 9 depicts an iconic comparison of the projects to the EFS data. Note that most phases show an *invalid data* icon. This indicates that we have not input EFS data for these phases. The Edit in TerraScan phase shows the nominal range icon. This means the phase is within the user

specified tolerance range when comparing EFS data to the actual phase data (we set our range to 5% but this is user adjustable).

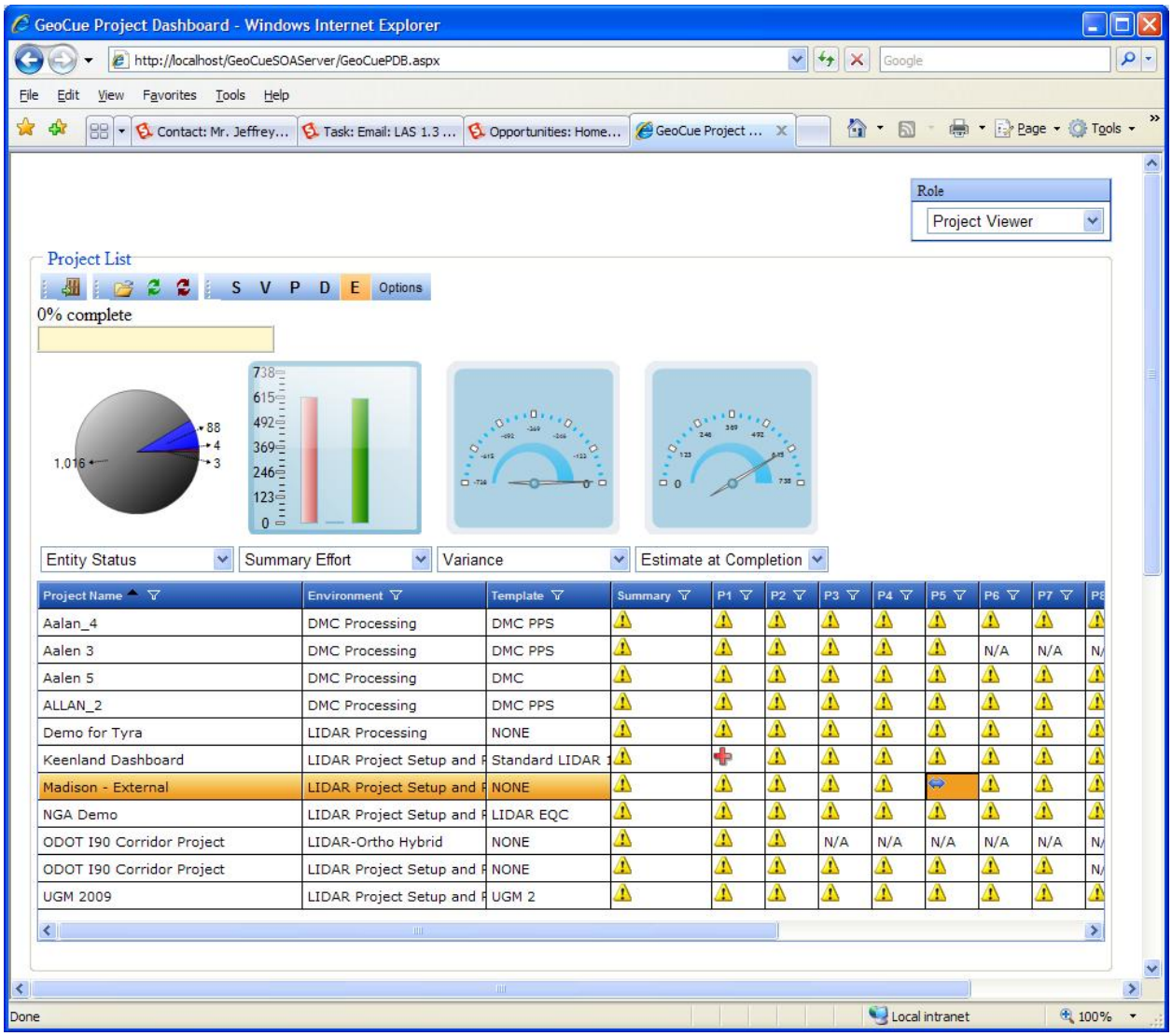


**Figure 9: Comparison of the Edit in TerraScan Phase to an External Financial System**

***External Phases:***

It is not desirable or, in many cases, practical, to host all project phases directly in the GeoCue Client hosted project. For example, you might have a phase called "Plan Survey" that you want to track in Project Dashboard but have no easy facility for including within the underlying GeoCue project. Project Dashboard supports the concept of "External" phases for these cases. You would generally employ an external phase when:

- You do not need to track and aggregate a number of micro objects into a macro phase

- Phase updates need to occur from remote locations via a web interface

***Exceptions:***

Exceptions are events that require attention. GeoCue and GeoCue Project Dashboard support two types of exceptions – WARNING and ERROR. It is usually up to the project designers to define these conditions.

When examining a layer of processing objects within a GeoCue project, an error definition is straightforward. For example, you would probably train your LIDAR QC personnel to declare problems that they could not fix within their inspection session as an ERROR. The tile would turn red in the GeoCue Map View and the Production Manager would take some corrective action. However, when you link thousands of these production objects to a reporting phase in Project Dashboard, it would be rather distracting to declare a phase error every time a single tile failed the QC step. This is especially the case if you have associated a *notification* with the event (discussed in the next section). Thus we have added the ability within Project Dashboard for the Project Manager to define ERRORS and WARNINGS for phases. Examples might include:

- Declare an ERROR for the QC phase if more that 3% of the objects enter the ERROR state
- Declare a WARNING for a phase if it is two days passed the planned start date and the phase has not yet started

We defined *hybrid* icons (discussed in a previous section) to allow the simultaneous display of an Exception with a progress status. For example, once a phase enters the In-Progress state (blue icon), you would not want to lose the Warning indication (yellow) that this phase started late.

***Notifications:***

It is often the case that an automatic notification of one or more project team members is necessary in order to quickly manage changing events. We built an extensive *notification system* into Project Dashboard that allows the Project designer (usually the Project Manager) to set *triggers* on all *state transitions* in the project. When a trigger fires, it causes an email notification to be sent to the specified users (or user groups).

The use of Notifications for Errors is fairly obvious. For example, you might link a Project Dashboard phase to the checklist step “Radiometric Post-Processing” in an Intergraph DMC workflow. You could then set an Event to declare a Project Dashboard phase error if more than 4 images went into an error state. Finally, you could set a notification such that the Production Manager will receive an email notification if/when this event occurs.

Notifications other than Error or Warning can be quite useful as well. For example, you may want the QC process on a set of rectified images to begin after 40% of the images are rectified.

This scenario can be achieved in a manner similar to that described above, but this time triggering on a percentage of Complete objects.

Finally, you can specify notifications on financial aspects of the project. For example, you could send a notification to executive management if the variance of a project exceeded +3%.

Think of notifications as automatic means of reading the important results of your *instrumented* project!

***Summary:***

We've spent quite a bit of time examining how our clients perform project management. We've had several years of discussions regarding tools that could improve the overall management process. The consensus has always been that micro-management tools are critical for macro success but they have to be automated before they will be successfully deployed.

We've used all of the client feedback and work process observations that we've made over these past few years to beef up the micro-management aspects of GeoCue Client and to design our new GeoCue Project Dashboard.

We truly believe that, with the new capabilities and tools of Release 6.0, GeoCue has become a framework that provides an entirely new approach to practical project management. Building up a management philosophy of automatic tracking of the critical micro aspects of a project and *triggering* the aggregated macro aspects (using Project Dashboard) shows great promise in bringing *usable* science to project management. The result will be (if you take appropriate actions!!) projects completed in a more timely manner at higher profits.

Is this the final word on managing GeoCue projects? Not at all! We believe that our early adopter clients will deploy GeoCue Client, our Distributed Project Management System and GeoCue Project Dashboard in innovative ways that we have not envisioned. This will drive new requirements into these products, resulting in incremental improvements with each new release. The important point is that we are teamed with you, our customers, in a virtuous development cycle that will provide you with new ways to improve your geospatial processes.

***Acknowledgements:***

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