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Avoiding the GIS-Model Disconnect

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Dear Fellow Modelers! Greetings and welcome to the third edition of Pat's Corner. Our hope is that these tips and tricks continue to be of benefit. Please feel free to email us at info@idmodeling.com if you have suggestions or comments on any of the Pat's Corner articles.

Introduction

While many utilities would like to fully integrate their model with their GIS in order to create a 1:1 model to GIS relationship so as to use the GIS to maintain and update their hydraulic model, few utilities have been able to achieve a reliable long term relationship between the model and the GIS. As a result disconnects form between the model and the GIS that are not always simple to resolve without resorting to a full rebuild of the model. Unfortunately while this allows the model to fully reflect the current state of the GIS, it often fails to leverage the knowledge and confidence associated with the current hydraulic model. This issue of Pat's Corner will discuss the ten most common root causes that derail integration efforts and result in a disconnect between the model and the GIS and identify suggestions on how they can be avoided. Knowing the "hurdles" of model to GIS integration is the first step in developing a plan to resolve them.

This article is based on current and past model integration efforts completed by IDM that formed the basis of a recent IDM presentation given at the AWWA DSS conference on August 25, 2008 in Austin, TX. A full copy of this presentation can be found by following this link:

http://www.idmodeling.com/Newsletter_200810/2008_1112_DSS08_Moore_Sierra_Avoid_GIS_Dissconnect_final.pdf

Avoiding the GIS to Model Disconnect

Ask any modeler and they will tell you that creating a model from GIS data is rarely a seamless process and never head-ache free! There are always hurdles and obstacles to overcome usually because the GIS was not initially set up with hydraulic modeling in mind. In

fact hydraulic modeling often requires the highest quality of GIS data and in order to integrate the model and the GIS the modeler has to perform processing and cleanup efforts to use the make a model created from GIS function properly. In other words, issues with the GIS need to be resolved to make the GIS "model ready." The goal of making a GIS "model ready" requires not only addressing existing issues, but also setting up procedures to keep new issues from arising and affecting the 1:1 GIS to model setup. This is essential for any utility that wants to maintain a 1:1 model to GIS integration. The ten primary hurdles to GIS and model integration follow:

Hurdle #1: Rally the Troops and Plan Your Attack

Gather all stakeholders and develop a plan and expected use for the hydraulic model.

One of the greatest challenges in maintaining a 1:1 GIS to model relationship is that the Operations, engineering, and modeling staff are not tasked with the same priorities as the staff who maintains the GIS. As a result it may be difficult to address issues in the GIS in a timely manner. Thus one of the first and most important steps in

developing a 1:1 model to GIS relationship is to gather all key stakeholders and decision makers and to agree upon a common model and GIS priorities. Coordinating efforts across departments so that issues identified within the GIS can be resolved in a timely manner may also require the agreement of upper management in setting aside time and work priorities for all ongoing projects. While this sounds simple, it is often this step that causes the greatest challenges in avoiding a disconnect between the model data and the GIS data. Achieving a common purpose and priority across the organization with the approval of upper management is essential for the success of any 1:1 model to GIS integration.

Achieving this consensus may come down to helping all parties realize the potential benefits of integrating the model and GIS data. Essentially this maximizes the effort required to build and maintain a GIS and minimizes the effort required to maintain and keep the

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hydraulic model up to date. An up to date hydraulic model can have many benefits for an organization from operations, to planning to engineering, but are all based on having an accurate model that users are confident in its abilities. Another benefit with revising the GIS to satisfy the requirements of a hydraulic model is that a GIS that is model ready is usually capable of satisfying any other typical GIS use. Thus addressing issues that are necessary to make a GIS model ready will only make the GIS better and useful for other purposes as well.

Lastly, it is important to identify the desired end use of the model. Having an agreed upon end goal is essential in addressing the later hurdles and should be addressed before this step is complete. Failure to agree upon an end goal can leave some stakeholders left out and result in a less than desired GIS or hydraulic model. A full understanding of the immediate use and users and the potential future use and users of the model allows for planning in all subsequent steps. Keeping lines of communication open between all stakeholders in the management, operations, engineering, modeling, or GIS groups is key in saving time and creating a model that will serve the needs of all stakeholders and its intended purpose.

Hurdle #2: Watch Out for Identity Theft

Identify a unique GIS ID that can be used to track and update the model from the GIS. Each element in the GIS database that will be imported into the hydraulic model must have a unique ID. This unique ID is used to tie the model database to the GIS database and is essential in maintaining a 1:1 GIS to model relationship. This ID should be unique across the entire GIS for a given model element type and should remain unchanged for a given element. The unique ID should never be re-indexed or reused even if an element is deleted from the GIS. Identifying a unique ID can be as simple as assigning a prefix to the objectID of all feature classes or could be more sophisticated. Known programs exist that can assist GIS staff in maintaining unique ID's across the GIS. Identifying a procedure for assessing a unique ID to GIS elements may require some forethought and planning but is essential to maintaining a 1:1 model to GIS relationship. This is important for updating the model from the GIS and for updating the GIS with key information found in the hydraulic model.

Hurdle #3: What's Hot and What's Not

Develop a process to clearly identify which GIS elements to include or exclude from the Model. One of the most difficult steps a modeler faces when building a model from GIS is to identify which elements are to be included in the model and those that are to be excluded. A clear agreement within a utility should be established on what will be included in the model. GIS elements included in the model must include point elements at the end of all pipe elements and should satisfy model topological requirements. The modeler must be able to clearly query out all elements that are to be included in the model using GIS data fields. If no clear GIS field exists to sort elements, then creating a field in the GIS and the model may be required. For example a field such as "IN_MODEL" can be used and populated with a "YES" or "NO" where appropriate to satisfy this requirement. Lastly model import queries can be setup to remove elements not typically modeled such as items which are abandoned, inactive, not served by the utility at hand, etc. Completing this step may require modifications to the GIS data in order to clearly identify what is modeled and what is not.

Hurdle #4: Don't Get Lost in Translation

Develop a process to facilitate easy translation of GIS elements into its required Model element type. Similar to Hurdle 3, the modeler often faces challenges of translating GIS elements into the proper model element type. For example, most system valves are not typically modeled as a "valve" but rather as a junction. However control valves are often modeled as a model valve. Some means must be developed to facilitate the translation of GIS elements into their proper Model element in order to maintain the 1:1 model to GIS relationship. Often, this step is not difficult except in cases when the GIS fields cannot be used to query out elements into their proper model element type.

New GIS fields may be used to also facilitate this step but may need to be initially identified by Modeler and then linked back to the GIS. A field in the GIS called "MODEL_TYPE" could be used to specify which elements will be junctions versus valves, pumps versus

junctions, etc. if necessary. If GIS data can be easily sorted using existing GIS fields then no additional effort is necessary.

Hurdle #5: The Leg Bone's Connected to the Knee Bone

Establish procedures and methods for maintaining proper GIS element topology. Modeling requires very specific topological rules and considerations within the GIS. These rules identify how the pipe and node elements are connected and thus identify how water can flow within the model. As a result topological concerns are very important for model accuracy and need to be resolved when identified. If these considerations are not satisfied by the GIS then the GIS based model will not behave hydraulically as expected. Use of a geometric network can facilitate addressing many model specific considerations if the rules assigned in the geometric network are established with hydraulic modeling in mind.

Model to GIS disconnects are often caused by topological issues in the GIS that cannot easily be resolved in the GIS. As a result they are often “fixed” within the model but are not resolved in the GIS. This creates a disconnect between the datasets that is only resolved when the problem is fixed within the GIS. GIS topological issues often arise because they are not always obvious or are problematic for other GIS applications. As a result they may exist unknowingly within a GIS. While geometric networks can resolve many typical issues observed, problems can still arise and need to be addressed for modeling applications.

Fortunately there are tools within most of the major modeling software packages that can be used to identify and even fix topological issues. See some of these tools include “Nodes in Close Proximity”, “Crossing Pipes”, “Orphaned Nodes”, “Orphaned Isolation Valves”, “dead End Nodes”, “Dead End Junctions”, “Pipe Split Candidates”, “Pipes Missing Nodes”, and “Duplicate Pipes.” All issues identified need to be resolved within the GIS in order to maintain a 1:1 model to GIS link. Make sure to setup a good process to identify and resolve issues found in a timely manner.

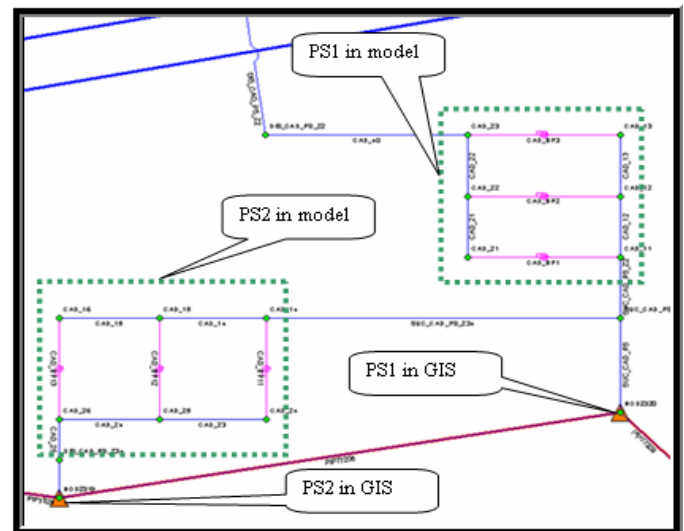
It is recommended that anytime the model is updated

or rebuilt from the GIS that topological checks are completed to make sure previously topological issues have been resolved and that no new topological issues have arisen. This step also serves as a verification of the issues identified in Hurdle 2 and Hurdle 3 because if problems arise from those hurdles they will be identified during the topological checks.

Hurdle # 6: Facilities are High Maintenance

A clear plan, process, and workflow must be developed to address how system facilities will be represented in the GIS. Model facilities include Reservoirs (water sources), Tanks (water storage), Pump Stations, Wells, and valves (such as PRV's, PSV's, etc). These elements may or may not exist within a GIS or may require modifications to use in the model because the GIS facility elements may be oversimplified or not include the detail required by the model. For example, the GIS may represent an entire pump station with multiple pumps by a single point feature. This same facility requires significant more detail within the model. An example of this can be seen in the following figure where the GIS represented two pump stations (pumping to two different pressure zones) as two points along the same GIS line element. The figure also shows the additional detail required by the model to represent these two pump stations.

Pump Station Detail Verses Point Representation



Facilities are marked as “high maintenance because they often require additional information that may not be included in the GIS. While Booster station facilities are sometimes included within a GIS with the

detail required by the model, there are other instances where the model will require additional information that is never included within the GIS. This may include piping and reservoir (source) elements around well sites or additional piping used when representing two side by side GIS tanks with a single hydraulically equivalent tank within the model.

A clear plan needs to be developed for the specific facilities for the GIS in question. This plan would include how the model facilities will tie to the current GIS elements and how to track “model only” elements that may be required. The addition of “model only” elements to a 1:1 GIS model has led IDM to start calling this 1:1+ modeling to represent the additional data outside the GIS that may be required.

Hurdle #7: Be a Bean Counter

Identify and track key Model data fields within the GIS data model. Tracking certain fields within the GIS database can greatly facilitate creation of a hydraulic model. Key model data is often identified by the modeler during model creation and may take a significant amount of time to populate and is essential for an accurate hydraulic model. This may include such information as identification of demand nodes, pipeline roughness factors, fireflow nodes and fireflow requirements, etc. This information if stored in the GIS (from a completed model) could be used to simplify model updates. Essentially if 90% or more of a system remains unchanged since the last model build from the GIS, then the modeler would not have to reassign this information when rebuilding or updating the model from GIS if it is already tracked in the GIS.

This is essential for maintaining the useful data gathered from previous model efforts so that previous model work is not simply lost. It is recommended that the utility identify a list of key model data that can be tracked in the GIS to ensure good model information is not lost.

Hurdle #8: Obituaries and Makeovers

Develop a plan for tracking changes and deletions of elements within the GIS. Updating a 1:1 model from the GIS can require significant effort. If a modeler knows that certain elements have not been changed since the last update, then the modeler would only

need to spend little or no time on elements that remain unchanged. This can only be accomplished if the GIS has a way of tracking which elements have been modified. Different utilities have proposed different methods of addressing this issue, but it may be as simple as tracking a data modified field within the GIS or by using a comparison tool such as FME to identify changes between data sets.

Another key is to track elements that are removed from the GIS that were included in the last model build. This is important because although there are some tools that can delete model elements not found in the GIS, deleted elements are often best dealt with by manually deleting them. This is often the safest method to use and is not model intensive because the GIS will not typically have many deleted elements to deal with. However, some means must be identified to track deleted elements in order to maintain the 1:1 model to GIS relationship.

Hurdle #9: New Paint or Extreme Makeover?

A clean plan of how often model updates will occur and how extensive model updates will be must be developed. Maintaining a 1:1 model from the GIS will require periodic updates. A clear plan needs to be identified for how often updates will occur and how extensive the updates will be. However it is important to realize that updating a model from the GIS is not simply importing new elements into the model that are in the GIS. Any time the model has been revised the modeler may need to revisit model demand values and demand allocations, model operational controls, and may want to validate or recalibrate the model. In addition the modelers must identify what model scenarios will be included within the updated model. This will require verification of model data sets and model operation to verify the updated model is operating as expected.

This step could be considered optional during initial planning but is essential for long term maintenance of a 1:1 model. It is also useful for all parties to fully understand all of the varied issues that are involved both in the initial model creation as well as future model updating so that the cost benefits can be weighed into how often model updating occurs.

Hurdle #10: Get a Game Plan Together

Gather all information from previous steps and develop a comprehensive plan of how the model is going to be used and maintained for both the near future and the distant future. The goal of this step is to summarize the information gathered by all previous steps into an organized plan. It is often useful to develop a flowchart of the update process that identifies the major steps in the model update process and who is responsible for each step.

Pilot studies can be very helpful during the development of this plan because it is difficult to identify all challenges without actually putting the plan into implementation. Use these studies to test the process developed. Revise the process as necessary and remember this plan is a living document and should be updated with every lesson learned.

Conclusion

In conclusion with a careful plan and approach, creating a hydraulic model from GIS data can be nearly or completely head-ache free! If these steps and recommendations are taken, the final product of your project will be a detailed hydraulic model that can be used for many years to come for master planning, evaluations, what-if scenarios and much, much more! The time it will take to plan will be well worth the quality and performance of your hydraulic model!

About Pat:

Mr. Patrick Moore, PE, Technical Solutions Director for IDModeling, has over ten years of experience in

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About IDModeling

IDModeling is a specialty service company, uniquely qualified to deliver hydraulic modeling solutions for both water/wastewater utilities and engineering consulting firms. IDModeling focuses on hydraulic model construction, development, calibration, analyses, and software or system-specific training as stand-alone services or within the context of master planning and operational studies. Bringing a customer-first approach to projects, IDModeling has seen international receptiveness and works with utilities and consultants to help satisfy SBE, MBE, and DBE certifications. IDModeling currently has regional office locations in Pasadena-CA, Tacoma-WA, Centennial-CO, Albuquerque-NM, Tampa-FL, and Wakefield-RI. For more information, visit www.idmodeling.com.