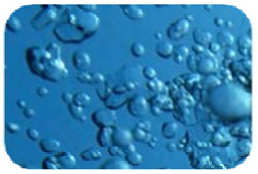
GIS & Hydraulic Model Integration

What Does It All Mean?

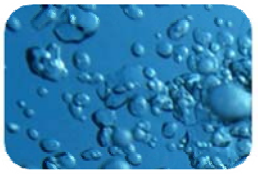
MSA

Basic Questions



- Is it really as complicated as it seems?
- What does "GIS integration" mean to utilities that are building models or using them for analysis?
- How do utilities leverage the investment that they are making in GIS into their model?
- How do utilities efficiently maintain the data in their GIS and model?
- When should utilities make the switch from CAD or stand alone modeling packages to GIS based ones?
- Should utilities maintain their model in-house or utilize consultants for it?
- GIS is used for so many different things, how does a utility balance the model requirements with other users?
- Do utility GIS staff need to understand hydraulics to interface with the model?

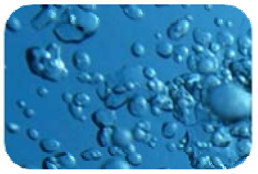
History



- Since the mid 1990s, and particularly since the advent of windows based GUIs with ArcView 3.X, the GIS user group has grown significantly
  - To prove the level of pent up demand for these tools was the success of ArcView 1.0

- Prior to that, GIS was limited to super technoids using high end UNIX workstations and command driven ArcInfo – not for the "casual user"
- Early on, GIS was mainly focused on resource mapping and general database development

History (continued)



- Models prior to the mid 1990s were typically text file based
  - Visualization of model geometry was difficult

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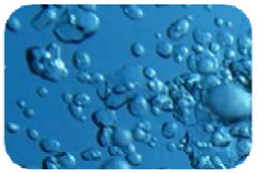
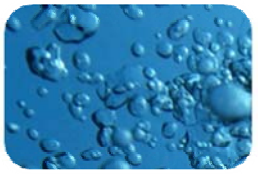
- Early attempts to link spatial mapping concepts to hydraulics typically occurred in the CAD environment
  - This was a huge step forward from a visualization and data QA/QC perspective
  - However there was no standardization of tools or functionality
- Early models were typically simplified “trunk” models due to the lack of computing power required to simulate more than a few hundred

History (continued)



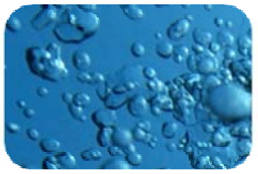
- Then around 2000, the concept of “GIS Integration” took hold
- Early on it was a lot more hype than reality, however the concept was a good one
- If GIS was to become the central and master repository for a Utility’s data then why not use it for hydraulic modeling as well
- The problem was that very few GIS databases had the information required, let alone were “clean” enough to convert into models

GIS Issues



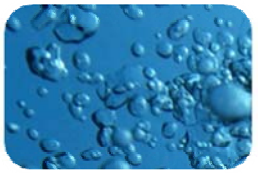
- Missing Attributes
- Unpopulated Attributes
- Most importantly they were not topologically correct, i.e. not connected correctly
  - Not snapped
  - Overlapping when they should have intersected or vice versa
- Facilities were either not includ or did not provide adequate detail in terms of piping or attributes

GIS Today



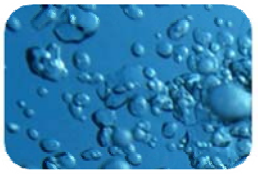
- It would be nice to say that all those issues have been addressed, however each Utility:
  - Is at a different point in their GIS development
  - Has different organizational challenges
  - Has different resources allocated to GIS
    - Budget
    - Staff
    - Skills
- Utilities now also contend with trying to integrate systems such as CMMS, Billing Systems and Asset Management into their GIS structure

Model - GIS Integration –
What Does it Mean?

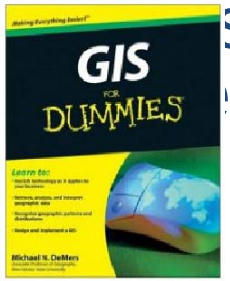


- Software Vendors typically say they have the "highest level of GIS Integration" or are "fully GIS Integrated", without clarifying what that means
- Typically there are two primary meanings
  1) Performing hydraulic modeling in a "GIS Environment"
  2) Utilizing a GIS Database as the "source" of model information
- However some are led to believe it means modeling directly from the GIS database – **It Does Not!**

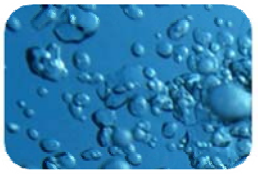
Current State of Affairs



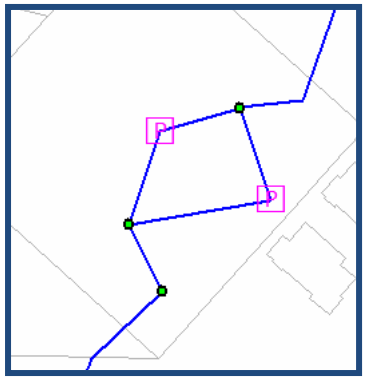
- At the time of writing this presentation – **No commercial software allowing modeling "directly" from the native GIS databases were available**
- All 3rd party software contain their own modeling database structure that must be populated
- By looking at modeling software advertisements you would quickly come away with a different impression
- Interestingly some of the vendors that sell their products as being "easy to u so offer "consulting services" to help s make the conversions
  - Easy to use but not too easy?



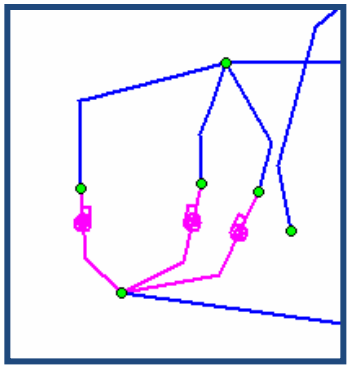
Model - GIS



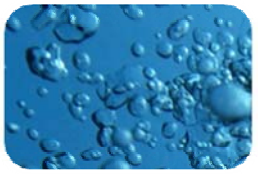
- So are separate databases a bad thing? – Not Necessarily
  - Most GIS still do not enforce the topological rules required for modeling
  - Hydraulic attributes such as C-Factors don't make sense to non-engineering staff
  - Facilities such as pump stations, wells and treatment plants have a high level of detail and require "control"
  - Models are not consistent in how they deal with pumps and valves from a data model standpoint



Pump as Point vs.
Pump as Link

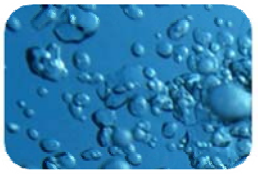


What Will it Take?



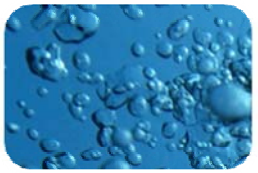
- Unique identifiers must be maintained for all elements
- GIS databases should utilize the “geometric network” to enforce connectivity rules
- Typically employ “complex edges” that allow features to be “associated and snapped” without splitting pipes at:
  - Service lines
  - Hydrant laterals
  - Valves
  - Other appurtenances
- Standard Hydraulics Based GIS Data Model
- Will it Happen? - Probably Not

The ESRI Tangent



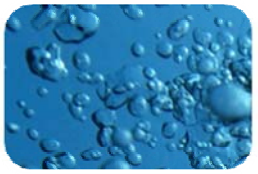
- Is the ESRI GIS monopoly good for us?
  - **Cons:**
    - User has little leverage in terms of alternatives
    - No Cost Competition
    - Products are released before all bugs are worked out
  - **Pros:**
    - Standardization in terms of data formats
    - Virtually all GIS professionals speak the same language
    - Allows modeling software vendors to standardize on data exchange and interfaces
  - **In general it is not good for the consumer to have any market dominated by a single company**
    - Competition tends to keep companies honest in terms of quality, pricing and customer service

ESRI (continued)



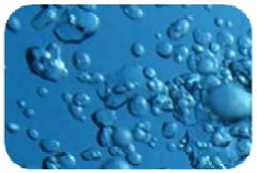
- Regardless of how we feel about ESRI, we are going to be working with them into the foreseeable future
- Bottom line - for those of us dealing with the nuts and bolts of data management, it does simplify things

Data Integration



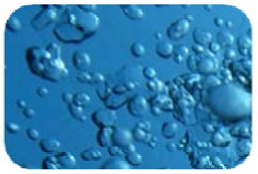
- Keys:
  - Define a GIS structure that accommodates known systems that utilize its data
  - Maintain flexibility for future systems
  - Maintain consistency in how the data is added, deleted or modified regardless of user
- The exchange of data between the GIS and model is just mechanics and the tools will continue to change
- The real value is in the data and the integrity of the data
  - It all revolves around **Data Maintenance**

Level of Detail



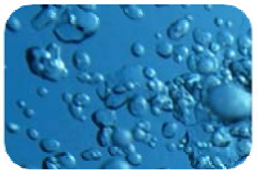
- All-pipe model versus an All-valve model
- All-pipe model has typically means:
  - All pipes except hydrant and service laterals
- An all-valve model typically means:
  - Including pipe segmentation at tees and crosses and may also include hydrant and service laterals

What level of detail should be included in hydraulic models?



- Computing power is now adequate for all but the largest systems to be all-valve models – but does that mean they should be?
- Recommend thinking about it from a “hydraulic” significance perspective
  - Does the additional level of detail provide valuable results for hydraulics or water quality?
- Significant additional segmentation adds unneeded data elements to the database and output files
  - Devil is in the Details – Lets not give him more places to hide
- Does anyone benefit?
  - Maybe software vendors that sell larger pipe models

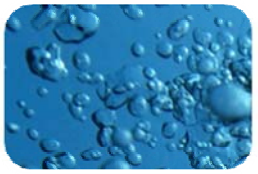
Level of Detail (continued)

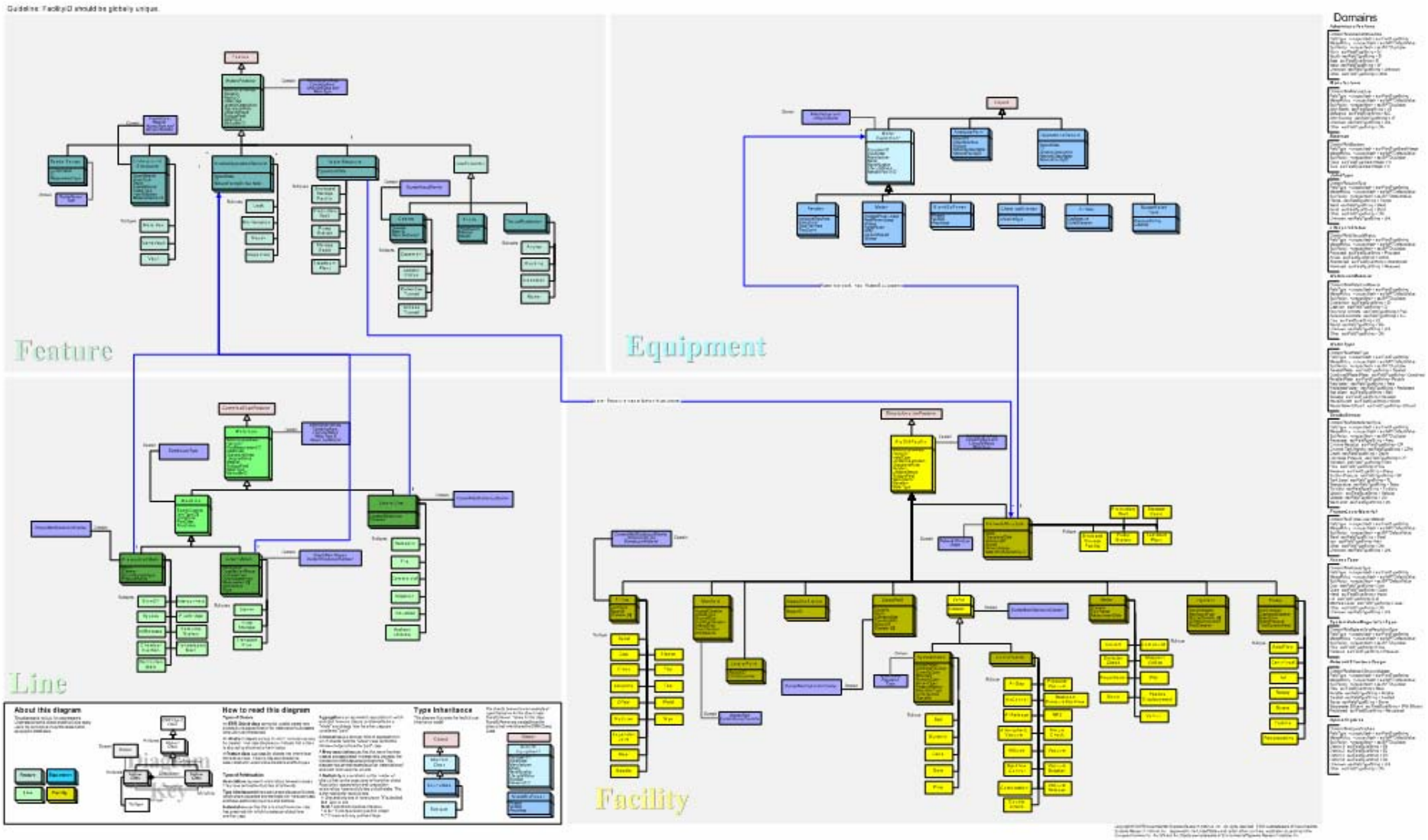


- Not including valves in the model doesn't mean we can't utilize that information
- GIS & Model proximity tools or geometric network information can utilize valve, lateral, hydrant data etc.

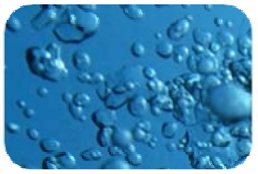
- **So what level of detail should be employed?**
  - Ultimately the answer is utility specific
  - One size doesn't necessarily fit all

ESRI Water Utility Data Model



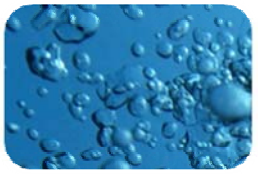


When to Migrate to GIS Based Models



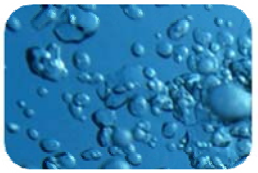
- GIS is the master data repository for the water system
- Connectivity issues have been evaluated and addressed
- GIS contains required modeling attributes
- GIS staff are “vested” in supporting the water utility
- Engineering Staff have at least some GIS skills
- Time & Budget has been dedicated to the effort

Industry Trends



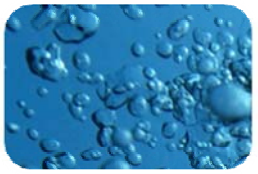
- Smaller and smaller Utilities are embracing GIS
  - Even if they aren't the ones maintaining it
- Much of the current software development focus is not on new or enhanced GIS integration tools
- MWH Soft
  - Asset Management
  - Water Quality Modeling
- Bentley
  - Recent tool for tracking one to many relationships
  - Energy and Operations Optimization

Some Take Away Thoughts



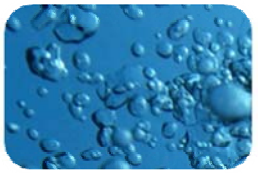
- Think holistically about data management & maintenance
  - In other words - Where are we today and where do we want to be?
- Understand the investment required to maintain your GIS and model databases whether you use:
  - In-house specialists
  - Consultants
  - Combinations thereof

Take Away Thoughts (continued)



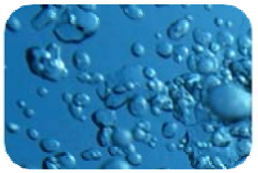
- Getting a high level review of database structures and maintenance processes can be an excellent investment
  - Set procedures for how data moves within the organization
- GIS Staff typically don't have the hydraulics background to do modeling and Engineers typically aren't the best ones to maintain the GIS
- Best configuration is when the GIS Staff reside in the Engineering Group
- The key, as with almost everything in life, is…… **Effective Communication**

Final Take Away Thoughts



- Almost everything is in a constant state of change:
  - Staff
  - Software
  - Organizational Structures
  - Priorities
  - Budgets
  - Users
- A well structured and maintained GIS can provide consistency and continuity when everything else changes

Thank You



- Questions

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