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We C.A.N. Do It: Actively Engaging Stakeholders in Modelling

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Abstract:
Active stakeholder participation is critical when trying to find local solutions to environmental problems. When consultants present externally developed suggestions, stakeholders often distrustful. This paper describes a novel methodology that encourages and stakeholder participation, trust, and cooperation while developing model-informed solutions to such issues. This process is illustrated by examples from recent work in the Bow River Basin in Alberta, Canada.

The Computer Aided Negotiation process (CAN) is a form of Computer Modelling for Decision Support developed by HydroLogics Inc. and facilitated with OASIS software. It has 4 main stages intended to keep stakeholders engaged and clear difficult problems in advance of the negotiation itself. These stages are:

1. Develop Performance Measures
2. Aggregate/Evaluate Data
3. Build Model
4. Develop and Evaluate Alternatives

The key to this process is that each step involves both developing materials for the negotiation itself as well as providing a forum for resolving major disagreements in isolation – i.e. preventing issues from compounding themselves. Data sources, for example, are often contentious. Discussing and developing a data source with the stakeholders prior to modelling allows the stakeholders to trust the model's results. Similarly, developing performance measures at the beginning allows stakeholders to legitimize their interests and gives them an opportunity to dive deeper into what they really want to see in a practical sense. What a stakeholder thinks they want, and what they really want after reflection, may be very different things.

Using this process HydroLogics has helped develop solutions in water management for nearly 20 years in both US and international settings. As environmental issues become ever more pressing, these processes have become increasingly critical.

***Keywords**:* Bow River; Engaging Stakeholders; Environmental Negotiations; Computer Aided Negotiation; Computer Modelling for Decision Support; Live Modelling; HydroLogics; OASIS

1. INTRODUCTION: ON THE LIMITATIONS OF MODELS & THE BOW RIVER

Modelling complex systems is tough. Data are often difficult to track down, player interactions can be murky, and results are difficult to validate. Yet, with an over-abundance of environmental and water issues continuing to plague us, demand for such models is on the rise. Months, even years can go into their development – to say nothing of the blood, sweat, and especially tears of the programmers. This makes it especially heart-breaking when, at the culmination of their labors, their product either sits ignored on the shelf or is discarded as biased. It is easy to forget that, although models are meant to inform management, managers must both trust and understand the models. This trust in, and comprehension of, the model is arguably even more important than accuracy. Model "truth" is critical, but stakeholder buy-in (from both managers and other participants) is what turns results into success. It is only when stakeholders take charge of the results, and push for implementation on their own, that progress can be made. The role of the model is merely to facilitate such action. This was the key to finding new operations for the Bow River in Alberta, Canada.

As with many systems, the Bow River itself forms a critical cog in the economy of Alberta. It is a major source of potable water for fully one-third of the province's population, sources the irrigation for much of the US$6.64 billion provincial agriculture industry (Government of Alberta, 2011), and is undeniably critical to the region's environmental health. Historically operating under a water use license program (analogous to US water rights), consistent growth led to the closing of the basin to new applicants in 2007 (Alberta Regulation 171/2007). Closing the basin will not stop growth, however, and the region is expected to double in size (reaching 2.85 million residents) by 2079 (Calgary Regional Partnership, 2009). With this in mind, The Bow River Consortium (BRC) was convened to ensure the persistent reliability of the system in the face of continuing development and growth. Coming from diverse backgrounds (see Table 1), yet sharing the same concern for the system, the stakeholders forming the BRC would become the core group of volunteers for our Computer Aided Negotiation (CAN) process. These stakeholders were typically representatives from their organisations that were well known for having "full system knowledge" in their respective areas of expertise (e.g. Irrigation District general managers, Senior Municipal Planning engineers, Town/County council members, etc.). Robust knowledge sets *in the room* allowed discussion to generally flow freely without interruption. Less knowledgeable participants often have to "check with my guy on that" which breaks the flow of negotiations, discredits the stakeholder, and generally interferes with this process. Although participants may not know the exact answer to a question, the must be able to answer the majority questions with a generalized or "close enough" response that allows discussion to continue.

TABLE 1: Bow River Project Research Consortium Members, by primary interest

Funders/Facilitators/ Technical Assistance	Municipal	Industrial	Agriculture	Environment/Recreation	Government/ Watershed Group
Alberta Innovates Energy and Environment Solutions	Calgary Regional Partnership	*TransAlta Corporation (indirect participation)*	Bow River Irrigation District	Ducks Unlimited Canada	Alberta Environment
Alberta WaterSMART	City of Calgary		Eastern Irrigation District	Trout Unlimited Canada	Bow River Basin Council
HydroLogics, Inc.	County of Newell		Western Irrigation District	Alberta Tourism, Parks, and Recreation	
Water and Environmental Hub	Rocky View County		Alberta Agriculture and Rural Development	Alberta Sustainable Resource Development	
Green Planet Communications					

(Sheer et al, 2013)

2. THE COMPUTER AIDED NEGOTIATION (CAN) PROCESS

The CAN process is a methodology that lays the groundwork for successful collaboration whilst simultaneously building the tools required to find novel solutions. Although overlap is common, it consists of four general stages:

1. Develop Performance Measures
2. Aggregate/Evaluate Data
3. Build Model
4. Develop and Evaluate Alternatives

2.1 Stage 1: Develop Performance Measures (PMs)

Performance measures are ostensibly the most important part of the model – a model is useless if it cannot answer the questions its users want to ask. Thus, in the CAN process the first step is to determine what the model needs to be able to show. Such measures need not be ordinal, with strict definitions of what can be considered "best," but rather should focus on cardinal displays that allow interested parties to quickly determine better/worse performance. Cardinal measures are suggested as they help to avoid getting bogged down in the particulars of scoring systems.

The goal in this stage is to develop any and all measures that have any potential benefit – nothing should be discarded and the floor should be open.

Starting with a diverse and numerous set of PMs serves a number of purposes:

- It creates a robust suite of metrics,
- It validates the interests and opinions of each stakeholder group, and
- It provides an opportunity for stakeholders to fully describe their positions and interests to other members of the group (Sheer et al., 2013)

Although the first point has obvious utility, the second and third points are arguably more important. The BRC was convened from a variety of interests including private environmental interests, major irrigation districts, municipalities, and more (see Table 1). Despite their willingness to work together, a long history of seemingly oppositional stances on water use can predispose stakeholders to viewing each other as rivals rather than allies. Bringing voice to the wide array of concerns in a safe space serves to remind participants of their shared values, and of the legitimacy (even if in conflict) of their interests. This is the first step in creating a cooperative atmosphere where ideas can flow freely.

During the Bow River Project (BRP) over 125 PMs were suggested and created for evaluation. Of those, only 24 were regularly reviewed, and about 10 informed most of the decision-making. For these stakeholders the major areas of interest were irrigation shortages, hydropower revenue estimates, recreational rafting days, elevation at an environmentally important reservoir, and flows in the river/continuing downstream (Sheer et al., 2013). Figures 1, 2, and 3 below are examples of the PMs created for this project.

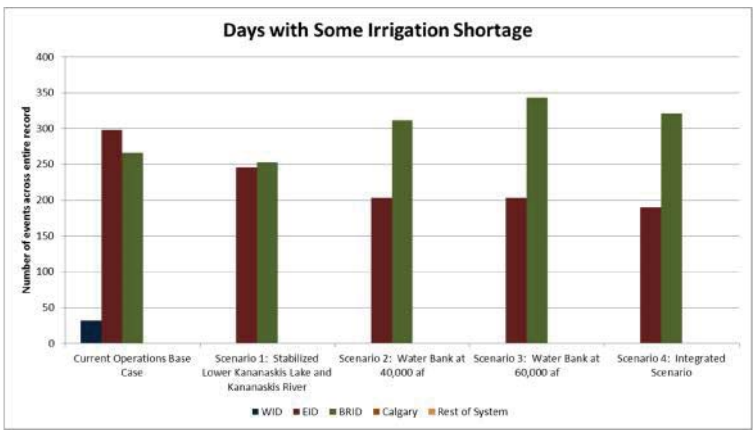

Figure 1. An irrigation shortage PM created for the Bow River Project. This compares the number of days showing shortages for each of the irrigation districts across a variety of proposed operations.

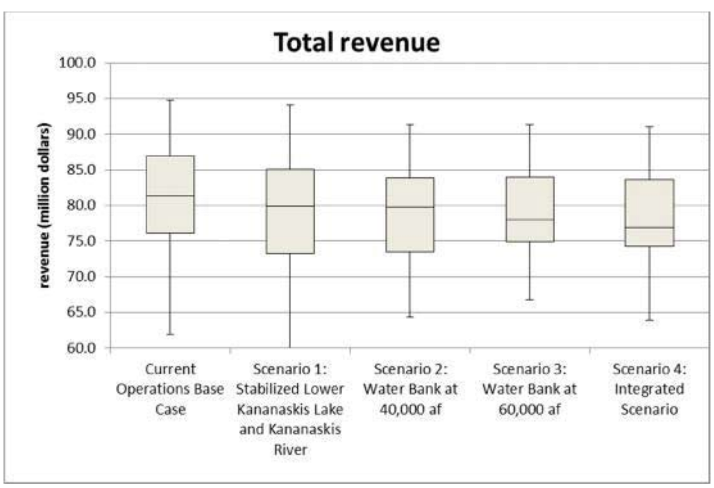

Figure 2. A hydropower revenue PM created for the Bow River Project. This box and whisker chart is intended to help describe potential effects of various operations on revenue for TransAlta Utilities, a major stakeholder in the system.

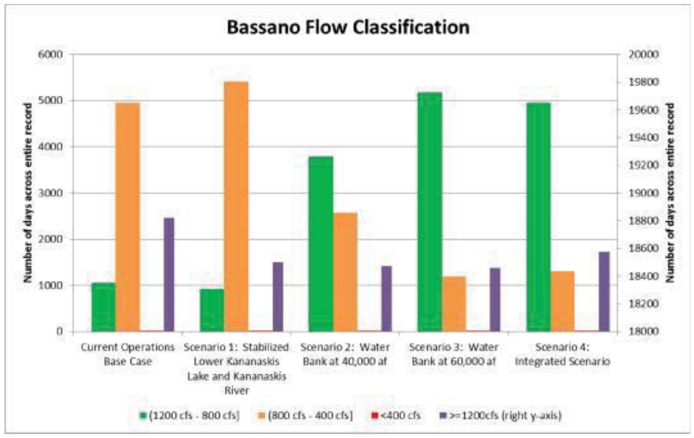

Figure 3. An environmental PM created for the Bow River Project. This chart compares the number of days experiencing particularly low flows in an environmentally sensitive reach across a variety of operational alternatives. This reach also acted as a surrogate for riparian health throughout the system.

It is also critically important that, during this stage, participants also consider the more general form of the products of this process. OASIS (the platform used in the Bow River Project), for example, is particularly valuable in answering water quantity questions. If the participants are primarily interested in land use effects, however, perhaps another set of software should be chosen. Furthermore, participants need to be clear regarding the expected costs of the project, both in terms of funding and time commitments. Thorough discussions during this stage, when facilitated by the modeller, should ensure that all participants are clear on what a particular model can and cannot do, and set the stage for both expectations and cooperation down the road.

2.2 Stage 2: Aggregate/Evaluate Data

Ostensibly a second stage, the collection and evaluation of data typically will happen at the same time as PM generation. It is, at least partially, informed by that discussion. There are, however, numerous data types and requirements that can be assumed regardless of PM discussion. For the model used in the BRP, these requirements consisted of things like: natural inflows to the region, reservoir and channel physical data, current operational strategies for storage and diversion, consumptive use and return flows, etc.

It is of the utmost importance, however, that this data be collected and verified as a group ahead of model development. Evaluating data after integration into an existing model is much more difficult than prior to construction. If stakeholders do not agree on the validity of data sources, they will not accept the legitimacy of results from a model that uses it. Establishing the veracity of the data before construction can sidestep many of the bias issues that would otherwise present themselves during the negotiating/alternatives phase.

In the case of the BRP, the vast majority of input data was provided by the provincial government, specifically Alberta Environment and Sustainable Resource Development. Even though the data they provided had been used in prior models, the BRC stakeholders felt that the implicit estimates for growth and water utilization were too high. As such, many of the consumptive use estimates were scaled down. Since the verification and modification decisions were made transparently and in the presence of all the other stakeholders, there were no objections to “demand downscaling” later in the process. If this had occurred after the simulation was built, it would open the door for criticism and undermine credibility. Since it was approved beforehand by the very individuals most likely to produce such criticism, the BRP managed to avoid another potential pitfall.

2.3 Stage 3: Build Model

After Stages 1 & 2, the requirements of the model or models should be very clear. With any questions regarding the direction of the model or sources of information resolved, it becomes much easier to coax information about how the system is run from the stakeholders.

In opposition to the earlier emphasis on open and group discussions, model construction inevitably requires a number of one-on-one conversations with individual stakeholders. The length, specificity, and need for substantial clarification/revision simply makes initial operation discussions too tedious for open collaboration. Further, a small degree of privacy often allows for more candor, and simpler explanations of rationale or reasoning behind operations.

Once the basics of a model are clarified, a base template can be formed for the system. With this in hand, it is important to bring the full set of operations before the assembled stakeholders. Although the level of detail does not usually have to be at a code level, it is often helpful to describe and show the direct implementation methodology. This serves several purposes:

1. Reducing Confusion: Presenting operations in a model in a group setting allows stakeholders to discuss why a system exists in its current state. Although modellers should be able to communicate this directly, the conversations between stakeholders that arise as a consequence of the public setting are invaluable. Furthermore, with a better understanding of how the system operates, stakeholders learn both what is possible and, in many cases, that there is already some attempt to meet those interests
2. Establishing Capability: Ideally, at the end of a CAN the model is released to the stakeholders to continue working with and testing alternatives. Showing them code, and adjusting it live with the group, helps to acclimate the group to the model and builds confidence.
3. Building Credibility & Ownership: As operations are discussed, inevitably mistakes or misconceptions made on the part of the modellers will arise. These mistakes, although perhaps painful at the time, are an absolutely critical part of the process. When stakeholders identify errors, and modellers correct them in front of them, credibility increases substantially. Further, through their direct and visible contribution, stakeholders begin to take ownership of the model (and thus the results as well). This is what gives any solutions or proposals that may arise from the process value and longevity.

A major part of the CAN process is a live modelling exercise (described in Stage 4). To support this, a model must have certain characteristics. First and foremost, the model must have a short run time. The point of the live modelling exercise is to be able to test many alternatives quickly, so the maximum ideal run-time is around 15 minutes. Secondly, the model must be easily modifiable “on-the-fly.” During a session, a wide variety of alternatives will be proposed. As it is impossible to foresee all of the options stakeholders will want to try, the model must be able to accommodate most suggestions they can invent. Finally, the input must be intelligible to operators. Stakeholders need not be able to read the code directly, but ideally they should be able to intuitively understand the rules and operations a modeller is creating as they go. HydroLogics’ OASIS modelling software was designed specifically for this purpose, although any model that can accommodate these requirements is suitable.

For the Bow River, BROM development took approximately nine months. Based on prior experience, this was a remarkably fast for the size and complexity of the model. The short time frame was enabled by some prior experience with the software in the region and a particularly well engaged group of stakeholders. It underwent at least three major revisions and countless minor adjustments and bug fixes. The model incorporates operations far beyond the limited scope of official legal arrangements (such as the water license system). During discussions of operations in early iterations of the model, stakeholders identified that building to the legal framework would unnecessarily constrain the range of potential alternatives. Since this group had a number of informal arrangements that acknowledged political realities and system limitations, it was decided that working from a basis that described “how the system was operated in reality” would be more productive. “Gentlemen’s agreements” not explicitly negotiated or codified thus became key aspects of the Bow River Operations Model (BROM).

The final schematic from the 2010 Bow River Project can be seen in Figure 4.

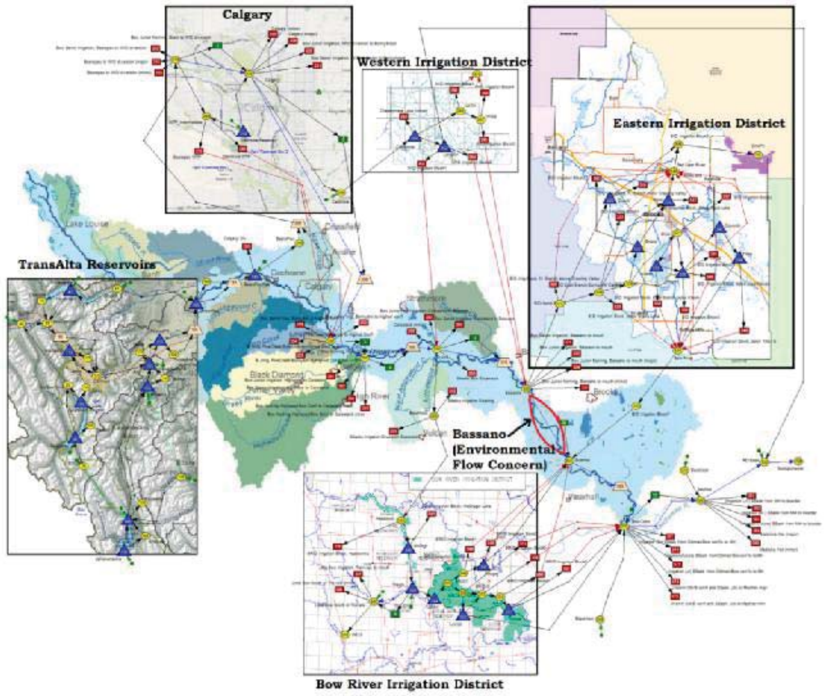

Figure 4. The full schematic for BROM, as it existed at the conclusion of the 2010 Bow River Project. Blue triangles represent reservoirs, red boxes represent users, and yellow circles represent river junctions or diversions. (Bow River Project Research Consortium, 2010)

2.4 Stage 4: Develop and Evaluate Alternatives

By stage 4 of the CAN process, stakeholders have: established their legitimacy, built a rapport, and become invested in the model. With this groundwork laid, running the model and testing new operations is comparatively simple. Although it is possible for modellers to undertake this on their own or with limited interaction, CAN again emphasizes collaboration. Leaning on the strengths of the OASIS software described above, live modelling session are a particularly productive method for developing alternative operation sets.

At its core, live modelling sessions are what the CAN process is designed to allow. The trust built in prior stages allow for a freedom of communication and a willingness to work together that creates a space for ideas to flow freely. To this end, it is important to create spaces where this flow is unimpaired. Typically, this involves bringing in additional modellers and grouping no more than about 8 individuals together with a diverse collection of interests (e.g. Environmental, Agricultural, Municipal, Recreational, etc) at each table (see Figure 5). Smaller groups facilitate more active participation and allow more ideas to be tested.

Figure 5. A breakout group during a live modelling session. Here five stakeholders work with one modeller to examine results from a recently tested alternative.

These groups can, and should, use the model to test any water management alternative they can think of. Particularly in the early part of the session, this allows a large number of ideas to be quickly suggested, modelled, and either discarded or preserved for future exploration/refinement. No suggestion should be dismissed out-of-hand, as “crazy ideas” may lead to implementable solutions. Over the course of a day, each table will slowly collect a (typically small) number of high performing alternatives. Throughout the session, the groups will break to share their work and compare notes. In the second half of the live modelling session, groups should focus on taking high performing alternatives and mixing/matching them to improve performance as much as possible. Afterwards, modellers can optimize the promising alternatives and confirm the results. These sessions ideally last two days, although single day sessions can work as well. By the end of these events, participants are usually excited, but exhausted.

Over the course of nine months, the Bow River Project had three of these live modelling events. In early sessions there were many suggestions that did not pan out or were stymied by the need for further model refinement. Errors in the model did not stall the exercise though, and new ideas came from unexpected sources. By the end, the Bow River Consortium found a particularly novel solution that involved the purchase of distributed storage in hydropower reservoirs for release under certain environmental triggers. Dubbed “the Water Bank,” this alternative showed substantial improvement in Environmental flows with only small increases in risk of shortages for Irrigation Districts and seemingly manageable reductions in hydropower revenue.

3. CONCLUSIONS AND BEYOND – WE C.A.N., WE DID, WHAT NEXT?

Ideally, and commonly, consensus is found on a single or group of alternatives during Stage 4 of the CAN The next step is turning that suggestion into action, though the particular approach depends on the circumstances under which the CAN was initiated.

In the Bow River project, modelling still had a substantial role to play after the CAN was complete. That said, this period was primarily driven by the stakeholders themselves. Thanks to the collaborative focus of the process, those individuals formed inter-personal bonds that helped to cement their relationships and encourage cooperation going forwards. Utilizing their individual strengths, local expertise, and networks of connections, they identified individuals and organizations to take the results to. By presenting a unified front their management suggestions were much more compelling. Editorials, direct presentation to decision-makers, and even direct advertising all played a role in their attempts to bring the “Water Bank” proposal to fruition.

Despite their coordination, though, implementation could not occur immediately. It was thus particularly important to keep stakeholders engaged throughout the long road to change. This was accomplished in a variety of ways, ranging from additional coordination/update meetings to follow-on projects. The intention in a CAN is usually to produce a tool that can continue to be used by the stakeholders themselves, and several stakeholders continued to model additional alternatives or upcoming projects in BROM. Since the end of the initial project, BROM has been used to perform a drought exercise, examine potential climate variability impacts, and test flood operations. This continued modelling exposed the value in coordinating the Bow River Basin’s operation with the rest of the South Saskatchewan River Basin, and BROM is now being expanded to include the Red Deer sub-basin to the north and the Oldman River sub-basin to the south.

Since CAN processes are intended to develop particularly novel solutions, it should not be surprising that some might require "closed door" negotiations external to stakeholders. In the case of the Bow River Project, the "Water Bank" proposal required fairly explicit public-private partnerships. With operations that could impact corporate profits, negotiating a specific agreement in the public eye was simply not feasible. Negotiations between utilities and the Government of Alberta are ongoing, but such negotiations need not stall stakeholder driven processes. In the Bow River, stakeholders decided to continue working with the model while the details of the public-private partnership were solidified elsewhere. These continuing modelling efforts have led to additional refinements that not only allow BROM to respond to new questions, but also reassert the original conclusions more strongly.

4. ACKNOWLEDGMENTS

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