FIRE SCIENCE DIGEST

Research Supporting Sound Decisions

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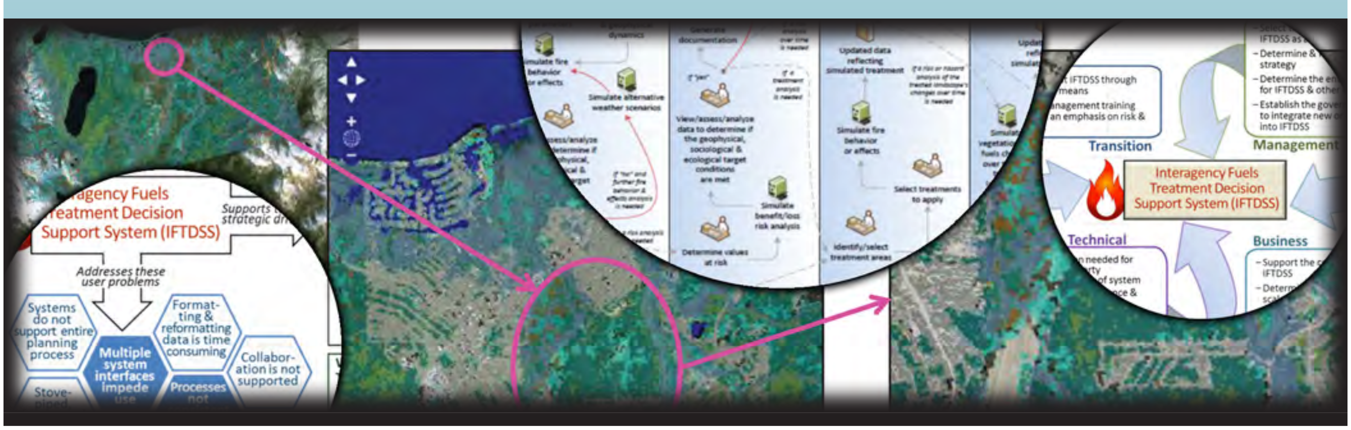
Taming the Software Chaos: True to Its Promise, IFTDSS Eases the Burden of Fuels Treatment Planning— and Does a Lot More Besides

A key problem reported by the fuels treatment planning community is the difficulty and inefficiency of evaluating and then applying many planning tools and applications. Fuels specialists have struggled to find, load, and learn all the different fuels and fire planning models, not to mention the interface of running, adjusting, and inputting data specific to each model without the ability to easily share inputs/outputs between models.

The Interagency Fuels Treatment Decision Support System (IFTDSS) was conceived as a way for users to learn one interface, access a variety of data and models all in one place, and pass data (inputs and outputs) easily between models. IFTDSS provides planners with the structure to reuse and share their work products, and it provides a consistent, basic analysis framework for all users.

The Joint Fire Science Program (JFSP) sponsored the design, prototype, early development, and evaluation of IFTDSS beginning in 2008 and continuing through 2013, working closely with fuels managers to ensure that IFTDSS remained focused firmly on proposed user needs and priorities. Those efforts were recently acknowledged when the Wildland Fire Information and Technology Executive Board formally approved IFTDSS on May 30, 2014, for further planning, development, and eventual operational deployment. With continued enhancements, IFTDSS could eventually become an official system of record for federal fuels treatment planning and become available for nonfederal users as well. Periodic progress reports will be available from the IFTDSS website (http://iftdss.sonomatech.com/).



A Better Way

You are a fuels specialist for a land management agency in a western state. You are tasked with assessing wildfire hazard in a hilly several-thousand-acre landscape dominated by ponderosa pine and mixed conifer, with willow and aspen in the riparian areas.

The landscape contains a small city that is expanding into suburban and semirural neighborhoods along a network of roads that once carried mostly log trucks—a classic example of the wildland-urban interface. Your agency needs to apply its limited fuels treatment dollars where they will do the most good. Which parcels are the likeliest to burn if ignited? Which ones would, if they burned, do the greatest damage to ecological or human values?

This sort of analysis is a ubiquitous and critical component of fire management—the kind of thing you do every day. Typically, you and your colleagues have had to break the task down into pieces and then sort through a bewildering array of tools—simulation models of fire behavior and fire effects, database management applications, and mapping software—to find the best ones to tackle each piece. You've had to wrangle your landscape data through multiple formats, depending on the limitations of the tool at hand. And then there is the time you spend learning how to use each tool and keeping track of patches and updates.

This time, though, it's different. You start your laptop, open a Web browser, navigate to a site called "IFTDSS," and enter a virtual space where everything you need is available at the click of a mouse.

"IFTDSS didn't reinvent any of the fire management tools," says fire management officer Jen Croft. "It just combined the best components of the tools that are out there right now and made them more accessible for the end users."

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Croft, who works on the Okanogan-Wenatchee National Forest, has become an evangelist for IFTDSS (Interagency Fuels Treatment Decision Support System; the unwieldy acronym is usually vocalized as "Iftydiss"). Croft welcomes IFTDSS as an elegant solution to the "software chaos" that has plagued fire and fuels managers for the past decade.

This chaos, according to IFTDSS's program lead Mike Rauscher, stems from the proliferation of stand-alone models and other software tools that were developed and funded independently, mostly in response to narrow research needs and without any central vision or strategy. "There was nothing out there that supported the [fuels planning] solution process from beginning to end," says Rauscher, a retired U.S. Forest Service (USFS) researcher who has spearheaded the IFTDSS effort since the first prototype was unveiled in 2009. "For that reason, it is absolutely critical to understand that IFTDSS is not another new fuels treatment system. It is a service integration framework that organizes and makes available a large number of preexisting software modules."

Barry Callenberger, another IFTDSS booster, is a former regional fuels specialist for the USFS in California who now runs a company called Wildland Rx, which contracts fire management services to public and private clients. Callenberger knows what software chaos looks like. "Let's say I'm going to do an analysis of fire behavior for a Forest Service office in Placerville, where I live," he says. "I'd have to go online and import weather station data. Then I'd have to go find the landscape file, if the Forest Service didn't provide it. Then I'd get the roads layers, then get the maps, and then they'd all have to work together in FlamMap [one of the many software applications]. Nine times out of 10 the layers don't work together, and a GIS specialist has to do it. It takes hours, if not days. But with IFTDSS, I have all I need to get my analysis within 15 minutes."

Croft can relate. "Sometimes I have to use seven different models to get one or two answers for a burn plan or a NEPA document [an environmental impact assessment under the National Environmental Policy Act]," she says. "As a fire manager, my time is unbelievably limited, and so is my skill set to remember how to use all those models." Juggling all the tools is hard enough for full-time permanent employees like her. "To ask my seasonal employees to write burn plans in an incredibly small timeframe, using seven different models, and crank that information out in a short time, and then be laid off for 6 months, and then go fight fire for 4 months, and then go back and try to remember how to run all these models ….. I thought, there's got to be a better way."

Funded by the Joint Fire Science Program (JFSP) and developed by its private sector partner, Sonoma Technology, Inc., of Petaluma, California, IFTDSS is intended to be that "better way"—a fully functional, integrated framework that makes available a suite of commonly used software models and other tools from an easy-to-navigate user interface.

IFTDSS and its components are Web-based, so users don't need to acquire, learn, or maintain a raft of modeling applications. IFTDSS also provides other critical components of a fuels treatment or burn plan, such as the library of fire behavior fuel models and the National Wildfire Coordinating Group (NWCG)-approved burn plan template.

IFTDSS incorporates the LANDFIRE geospatial database, from which users can create tailormade maps for a given landscape. The maps can be exported to Google Earth, which offers additional mapping and viewing capability. IFTDSS can be used at multiple scales, from small sites to landscapes up to several hundred thousand acres, to analyze fire hazard, assess risk, plan fuels treatments, and plan prescribed burns.

Most important, IFTDSS extends powerful modeling and predictive capability to people who may be very good at assessing hazard and risk from forest fuels but who may not be trained programmers, GIS experts, or database wizards. This is good news for smaller agencies, says Forest Schafer, forester for the North Lake Tahoe Fire Protection District. "There are a lot of local jurisdictions that don't have a lot of technical resources or knowledge to be able to perform fire modeling or planning," he says. "For us, IFTDSS really breaks down a barrier to creating an effective fuels management program."

Glowing Review

IFTDSS's current version, 2.0, is now being beta-tested by Croft, Callenberger, Schafer, and a host of other users. The IFTDSS package, including detailed instructions, tutorials, and help screens, is posted on Sonoma Technology's website (http://iftdss.sonomatech.com/). Stacy Drury of Sonoma Technology and IFTDSS's lead science advisor and technical transfer specialist, invites users to log on, give it a try, and send him detailed feedback.

IFTDSS 2.0 got a glowing review from an independent evaluation team at Carnegie Mellon University. The review team from the university's Software Engineering Institute (SEI) studied policy documents, interviewed fuels planners and other key stakeholders in the wildland fire community, watched IFTDSS as it moved through its development phases, and participated in developer and user workshops. In its July 2013 report, the reviewers commended the IFTDSS team for both "looking up" to meet national policy goals for risk-based fuels management and "listening down" to meet the needs of local and regional fire and fuels managers.

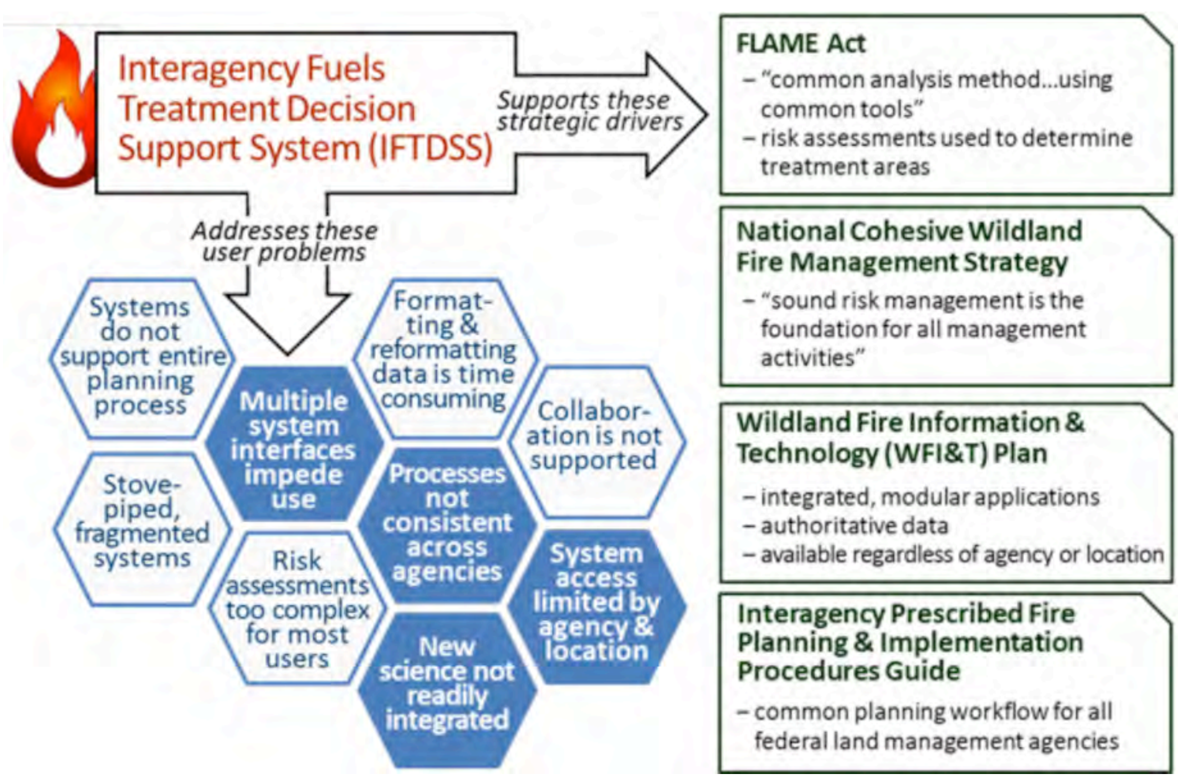

Figure 1. Summary of Software Engineering Institute's findings after evaluating IFTDSS.

High Praise from Software Engineering Institute

IFTDSS won kudos in its evaluation by Carnegie Mellon University's Software Engineering Institute. Here are highlights from a report written by the institute.

"Overall, IFTDSS:

- Demonstrates key principles of the Wildfire Information & Technology (WFI&T) Plan.
- Provides an enterprise solution for the strategic goal of improved…fuels management planning.
- Demonstrates a framework that could support end-to-end training.
- Allows for improving the management of fuels treatment through its data management and its incorporation of scientific models.
- Can be extended beyond fuels treatment to other domains."

"IFTDSS was also an exemplar as a program:

- The program 'looked up' to meet agency and department strategic mission goals.
- The program 'investigated across' to conform to agency and department IT governance.
- The program 'listened down' by actively soliciting user feedback.
- The program had achievable scope and schedule."

"While there are some technical concerns regarding IFTDSS, the greatest challenge …. is the lack of the governance and policy needed for the wildland fire community to achieve its stated strategic and information technology goals."

"The feasibility of IFTDSS as a software tool is no longer a question. We recommend IFTDSS be deployed in a limited manner (similar to its current use) while bringing IFTDSS to a 'production level' state and preparing field users to more-effectively use IFTDSS in the course of executing their missions."

While mentioning some remaining challenges (see Figures 1 and 4)—notably, IFTDSS needs a security system that will permit users to collaborate across agencies and locations—the SEI evaluators concluded that IFTDSS is ready to be launched and used for real-time fuels planning work. IFTDSS greatly enhances the usability of the key models used in fire and fuels planning, the reviewers concluded. The workflow concept "helps users understand 'what to do next' by leading them through standardized processes" (see Figure 2). Models run in the background, which means users "don't have to wait for model execution to complete before they can proceed. …. Users can perform other tasks until … their workflow is completed." And IFTDSS is extensible, meaning its architecture lends itself to continual improvement of existing models and addition of new ones.

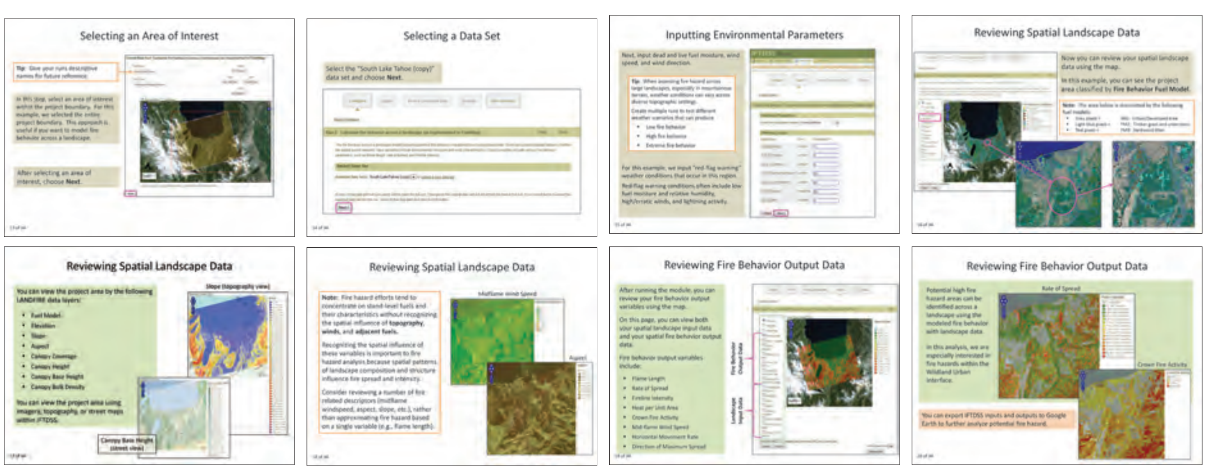

Figure 2. This sequence of steps from the hazard-analysis tutorial shows how to use IFTDSS to select and narrow down an area of interest, capture the appropriate dataset from FlamMap, and enter the environmental parameters for the selected area. IFTDSS maps the landscape and fire-behavior data for the user's review. It also enables the user to export the data package to Google Earth, making more landscape information available along with additional viewing and editing capabilities.

The Power of Workflows

IFTDSS is organized around workflows—recipes for common tasks that suggest the best tools to use for each step of the job. IFTDSS offers six workflows so far: data acquisition and editing, hazard analysis, risk assessment, fuels treatment, vegetation analysis, and prescribed burn planning (see Figure 3). Each of these can be customized through variable pathways.

When the hazard analysis workflow is selected, IFTDSS will walk the user through a series of model runs that analyze and map the fire hazard across the landscape.[1] The user starts by acquiring landscape data from LANDFIRE, accessing this database from within IFTDSS. The user defines the area they want to look at by drawing a shape around it or entering the proper location coordinates. After IFTDSS uploads the LANDFIRE data for that area, the user enters the appropriate environmental parameters, including moisture content of the types of fuel that are present (based on an established set of fire behavior fuel models, also part of the IFTDSS package), as well as wind speed and direction.

[1] To see this workflow illustrated in a real-life example, please see the tutorial "Performing a Landscape-level Hazard Analysis," part of the IFTDSS Help literature, available on the Sonoma Technology website, http://iftdss.sonomatech.com/. All user documentation can be accessed without a login.

Using this information, IFTDSS runs the model FlamMap, producing a multilayered map of the area's topography and fuels distribution. The user can then ask IFTDSS to run the model once or three times or many times, varying the environmental parameters or the fire behavior fuel models according to their best judgment of actual conditions. The final product will be a map highlighting the areas that represent the greatest wildfire hazard, in terms of flame length, rate of spread, fireline intensity, and other variables.

The map can be printed as it is, to include with the fuel treatment or burn plan. Or the map can be displayed on a computer screen to explain management decisions to neighbors and stakeholders. The map layers can also be exported into Google Earth, where additional spatial information can be overlaid, such as locations of roads, schools, airports, and hospitals.

If the user wants to take a closer look at the most hazardous areas, they can do additional modeling runs on subsets of the LANDFIRE data that were initially acquired. These model runs can be analyzed together with additional data sources, such as aerial photos or information from site visits, to help determine the most effective places to spend scarce fuel reduction dollars.

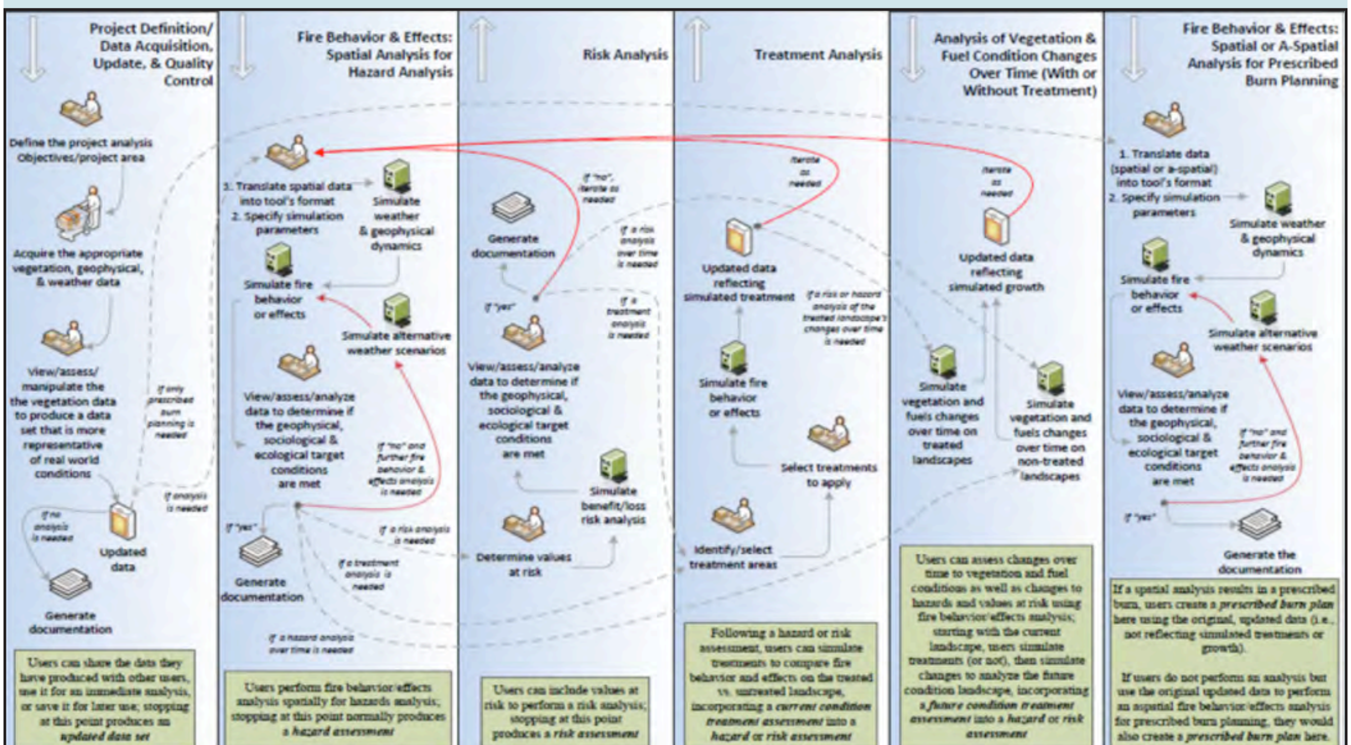

Figure 3. High-level description of all IFTDSS workflows.

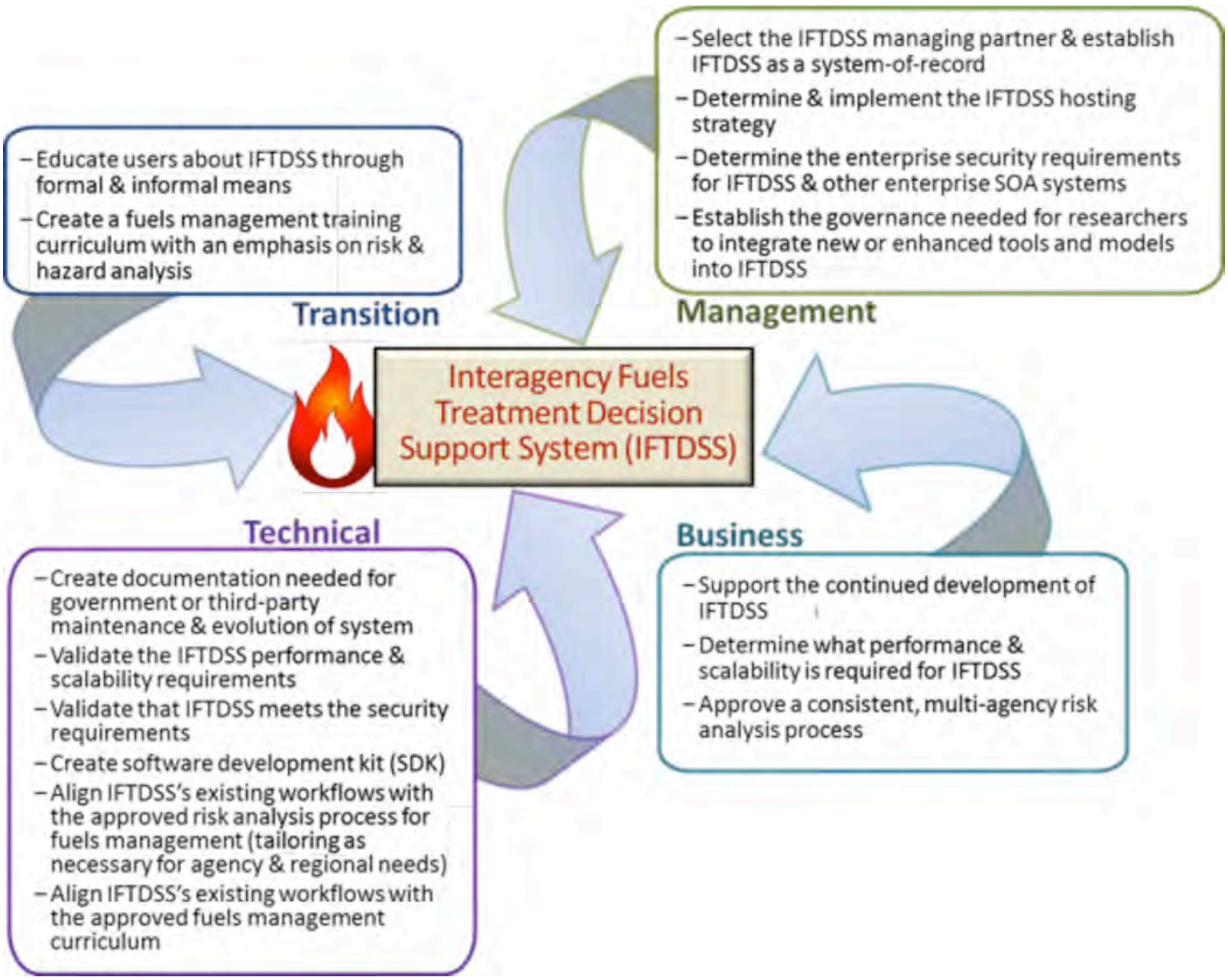

Figure 4. Summary of Software Engineering Institute recommendations after evaluating IFTDSS.

A Unifying Technology

IFTDSS has come a long way from its proof-of-concept days. The idea of integrating diverse software modules and tools was raised in a 2008 study by the SEI, which confirmed the "software chaos" problem and recommended that the wildland fire community develop a unifying technological solution and engage its various stakeholders in accepting, understanding, and using it.

In 2010, the JFSP called together a special working group, which recommended funding a service integration framework for fuels treatment. The JFSP contacted Sonoma Technology, which had experience in developing the BlueSky modeling framework, to lead development of an IFTDSS prototype. Sonoma Technology assigned Tami Haste as project manager and hired fire ecologist Stacy Drury to design the workflows and manage training and user evaluation and feedback. Daniel Pryden and David Noha became the lead software architects.

The JFSP working group had found a couple of precedents for this type of application within the wildland fire arena. One is the Wildland Fire Decision Support System (WFDSS), a Web-based framework that combines fire models and data acquisition tools behind a unified interface. WFDSS is mainly directed at managing wildland fires. In fact, it is the "system of record" for that purpose, meaning it is the officially approved tool for agencies that manage and fight wildland fire. Another service integration framework is BlueSky, which combines fuel consumption and emissions models for predicting the output of smoke from a wildfire. Neither of these frameworks is specifically aimed at managing fuels.

The third existing modeling framework, ArcFuels, is intended for fuels management and prescribed fire. ArcFuels is powerful and flexible in the hands of a well-trained analyst, but it can be complicated to use, and it relies on proprietary software. The JFSP working group wanted something both easier and more universally accessible—a system, says Rauscher, "that could be used by most fuels managers and not just the experts."

This need had already been recognized at the highest levels of policy. In 2008, the NWCG, consisting of the fire directors of each of the five federal land management agencies, produced a "modernization blueprint" for wildfire enterprise architecture. A subsequent review of the current state of cross-agency information technology affirmed that the "software chaos" problem was real. The review provided the basis for a plan to carry out the recommendations of the modernization blueprint.

The plan that emerged in 2012, titled "Wildland Fire Information and Technology: Strategy, Governance, and Investments" (WFI&T Plan), called for a Web-based, service-oriented software framework that could be accessed universally by users in different agencies on different computer platforms. The plan called for an integrated data environment, the linking of software modules into organized workflows, and capability for collaboration and information sharing. The system had to be open to continual innovation—capable of incorporating improvements in fire science research and modeling and computing technology.

The JFSP's group approached Haste and her team and asked them to design a software framework that organized the main fuels management models and tools according to the workflows they typically supported. Drury, in charge of designing the workflows, was a boots-on-the-ground researcher right from the start. He crisscrossed the country to observe how fire and fuels managers did their jobs. "I was trying to get a feel for people's modeling needs, the tools they were using, and the audiences they were trying to reach," he says. "It wasn't enough to conduct surveys or talk to people on the phone. People will tell you one thing when they're actually doing something subtly different, sometimes maybe quite different."

"Stacy [Drury] and Mike Rauscher went above and beyond to get ideas from practitioners," says Erik Christiansen, retired program lead of the Department of the Interior's fuels and biomass program and who served on the JFSP working group. "That's why [IFTDSS] looks so intuitive now—it's because those people said, 'This is what I need to do my job.' And Stacy and Mike listened."

"We've reduced the software hurdle and streamlined the complexity, but IFTDSS should not be regarded as a 'black box.'"

One message came through loud and clear: simplify, simplify. Says Drury, "They would tell me, 'If it's too complicated to explain in 5 minutes, I lose my audience.'" This suggested to Haste and her team that IFTDSS had not only to be easy to operate, but it had to produce maps and reports that were easy for a lay person to grasp. "Yet, at the same time, we had to be sure we didn't dummy down the science," says Drury, because IFTDSS's outputs have to be credible and scientifically defensible. "It still takes a knowledgeable fuels treatment specialist to use IFTDSS properly," adds Rauscher. "We've reduced the software hurdle and streamlined the complexity, but IFTDSS should not be regarded as a 'black box.'"

Not a Black Box

IFTDSS is intended to make fire and fuels management easier for trained professionals. It is not intended for untrained users who are unfamiliar with the capabilities and limitations of its component models, cautions Mike Rauscher. "Making fuels treatment planning so complicated that only a few agency experts can do it is not the right way to ensure credible results," he says. "For that reason, IFTDSS sometimes hides certain complexities of models that may not be needed for a given task." But some researchers are concerned that IFTDSS could encourage a naïve "black box" approach to running models and interpreting their results—a complicated enterprise that is as much art as science. Now that IFTDSS has been adopted by the fire management community, Rauscher says, all users will need to be trained to recognize its default parameters, as well as be familiar with the assumptions built into the component models.

The People Factor

As Haste and her team were developing IFTDSS's technical side, the JFSP team was working on the "people" factor—the need to engage the wildfire community from the outset. Early on, JFSP Communications Director Tim Swedberg had surveyed wildland fire managers nationwide to get a handle on their main information technology concerns. He met with committee leaders of the interagency NWCG, visited fire and fuels managers across the country, and asked questions at NWCG training classes.

Besides gleaning a lot of good technical suggestions, the JFSP team began to get a clearer picture of the various stakeholders who would need to buy into the developing new system. They grouped these interested parties into five categories (see Figure 5): the fuels planners who would use the system, the model developers who would write the software that powered it, the database stewards who would manage the information, the IT managers who would take care of the system infrastructure, and the senior managers who would govern, direct, fund, maintain, and improve the system.

All these stakeholder groups struggled with "software chaos," but the problem presented itself differently to each group. The JFSP team understood that any new system had to make things better for all stakeholders. For example, it not only had to make modeling and data presentation quicker and simpler for fuel managers, it also had to develop standards and guidelines for developers of models and other software, and it had to address the challenges of developing cross-agency information technology and security protocols for IT managers and high-level leaders.

In short, says Rauscher, "We knew we had to deliver a whole product: the technology, plus everything else needed for the technology to be accepted and used. The essence of this is to engage each stakeholder community so that each one feels a responsibility toward the new application, as well as an awareness that they are gaining significant advantages from it at the same time."

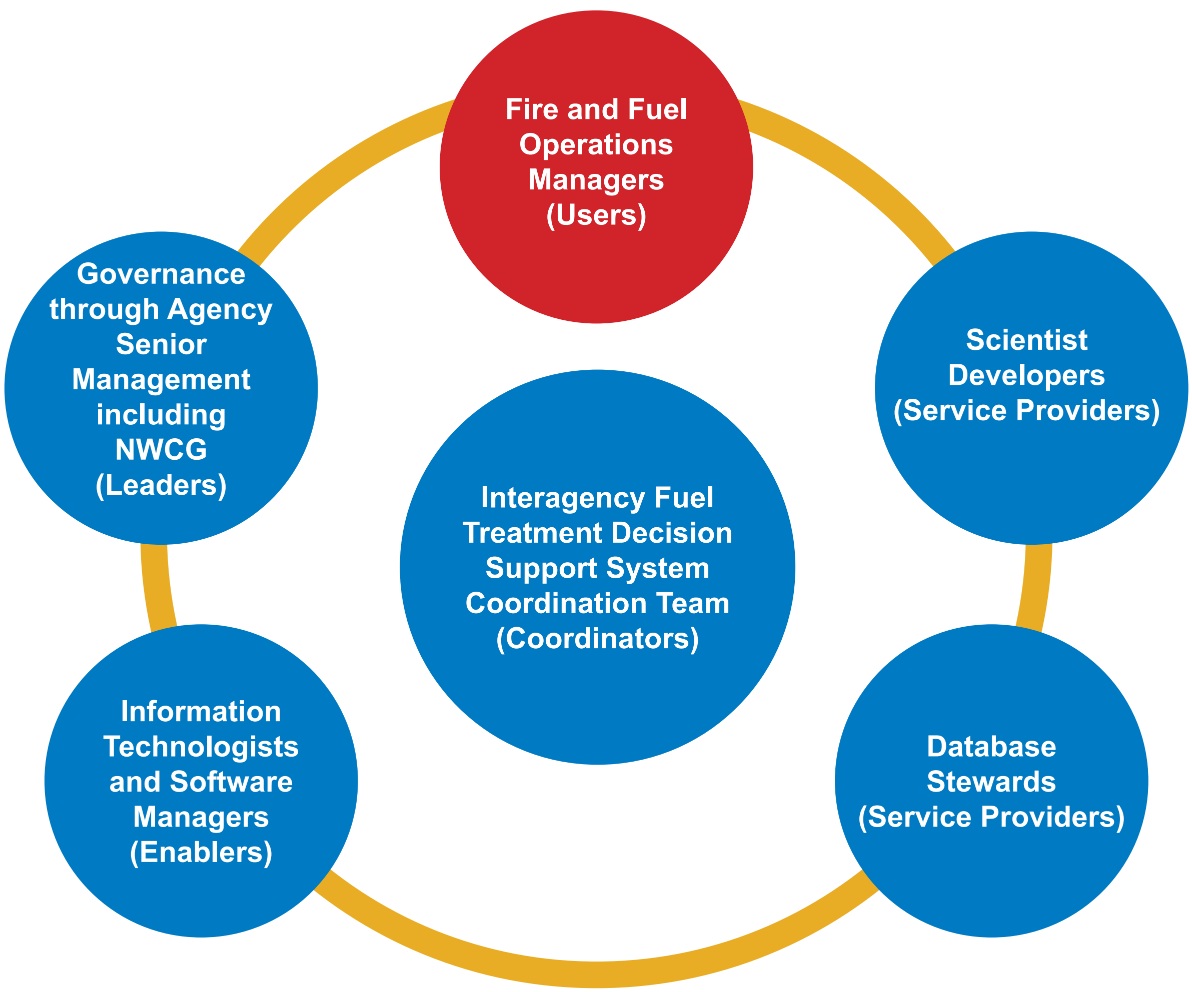

Figure 5. Key stakeholder groups of IFTDSS.

Agile

The JFSP team devised a communications strategy that identified the "early adopters" within each stakeholder community and engaged them to give feedback on the first few versions of IFTDSS. Responses were folded into successive updates, in a strategy known as "agile software development." In 2011, Haste and her team produced their first functional test version, IFTDSS 0.4, released it to prescribed burn planners nationwide, and collected feedback via detailed interviews.

Respondents made many suggestions, with the main ones centering around two major desired improvements. The first was to make the standard NWCG burn plan template accessible and editable from within IFTDSS. The second was to add some of the familiar tools and report formats from common models such as BehavePlus. "People were hesitant to use a new tool unless it looked something like what they were used to," says Drury, "even if, a lot of times, those tools didn't do exactly what they wanted. But our goal was to get people using the system, no matter what it took. So we put those features in. And it's funny: people stopped worrying about it then."

Haste and her team incorporated the NWCG burn plan template and made it editable from within the IFTDSS user interface. They also refined the mapping capabilities, and they developed an extensive, well-organized set of help screens and other user documentation. The IFTDSS documentation can be viewed without a login on the Sonoma Technology website: http://iftdss.sonomatech.com/.

The current 2.0 version has just undergone another round of review. Again, Drury says, there were several suggestions for improvement, "but the general drift [of the feedback] was, 'It's really looking good. You're almost there.'"

Key improvements desired by the beta testers were the ability to upload user-created shape files (polygons can be created in IFTDSS, but the system can't work with files that were created in another application) and the ability to customize the NWCG burn plan template according to differences in regional environmental conditions. Reviewers also wanted IFTDSS to report the different modeling outputs more quantitatively. "They wanted to be able to show, for example, that if they did such and such a treatment, not only would fire behavior be reduced, but it would be reduced on X thousand acres by X percent," says Drury.

Another important suggestion was to add the ability to easily compare simulated fire behavior and effects with actual measurements taken after a prescribed burn. This, says Tim Sexton, would greatly add to the value of IFTDSS for landscape-scale monitoring and adaptive management. "Let's say you develop a prescription in IFTDSS, and you implement that prescription," says Sexton, who manages the USFS's Wildland Fire Research and Development program and who also served on the JFSP working group. "That prescription may be carried out in any of a wide range of environmental parameters. It would be good to be able to feed in the specific conditions that were in place when the burn was conducted" and see how well IFTDSS's modeling predicted the outcome. "Right now, IFTDSS does a good job of planning," says Sexton, "but it needs that added followup capability."

Path Forward

Incorporating these improvements into IFTDSS would not be a trivial task, "but it's definitely feasible," Drury says, "with perhaps a year of solid work." Given the recent decision of Forest Service and Department of the Interior leadership, planning is underway to provide for continued development (security, protocols, training, etc.) and eventual operational deployment where IFTDSS may become the system of record for fuels treatment planning.

As IFTDSS becomes more widely adopted, its advocates envision far-reaching benefits. "IFTDSS gives us a ready-made platform for training," says Christiansen. "Beyond that, it will help us come to a standardized way of planning for fuels treatments in the agencies across the nation. And this, in turn, will help us better train our local fuels planners to get more treatments done with fewer resources. These are benefits I didn't fully realize back when we were first talking about this."

IFTDSS also promises to help stabilize institutional fuels planning knowledge. Says Sexton, "There are something like 500 or 600 fuels planners in the Forest Service. When one of them moves on or retires, it's hard for another person to step in behind them." Having IFTDSS as a system of record "will add tremendously to that corporate knowledge, and it will facilitate learning much more quickly."

Sexton envisions IFTDSS itself becoming a learning system, one that could be "trained" to interpret followup information on actual fires and feed it back into subsequent prescriptions. "If it could incorporate this kind of feedback loop, then over time both the system and the users would become more proficient," he says. "That's the endpoint I'm looking for in this application." With IFTDSS, "we have made a significant step in assuring that fuels treatment in the future will be targeted, prioritized, and applied to the areas that most need treatment, and not just thrown across the landscape."

As an example of this, another beta tester of IFTDSS used it recently to show the real-world effectiveness of a prescribed fire on Arizona forestland that was subsequently burned in a wildfire. "I was able to go in and demonstrate how the earlier prescribed fire reduced fuel loading," says Bil Grauel, fire ecologist for the Bureau of Indian Affairs, "and then I modeled what would have happened had prescribed fire not been done." The modeling demonstrated that the fuels treatment significantly dampened the effects of the later wildfire. "I actually had to finish the job in WFDSS because of the polygon problem [i.e., the inability to upload user-created shape files into IFTDSS]," Grauel says. "But that shows you can use this system to demonstrate fuel-treatment effectiveness."

Show, Don't Tell

This demonstrative capability may be IFTDSS's greatest gift to managers who have to justify their assessments of hazard and risk. With IFTDSS, they can create a living map that shows, for example, why a prescribed burn should be done here but not there or why the brush should be cut and hauled away in this part of the forest rather than that part. "If you [simulate a treatment] in an area, you can see the effects of that treatment on fire behavior immediately," says Callenberger." That's another thing that [without IFTDSS] sometimes takes days. With this tool, you can almost do it in front of a community meeting."

If you can show your stakeholders what you're doing and why, they are more likely to trust your judgment in matters of risk and hazard. This is true, says JFSP Director John Cissel, whether you're talking to a town council, your regional forester, or the agency higher-ups who evaluate your environmental assessments. "Describing risk is difficult, because we all hold different ideas of what 'risk' means. With IFTDSS, we can draw a map and put in those features that are most important to people, and then we can simulate a fire and show exactly where the harm would occur. This is a priceless tool for informing and engaging and building trust among all our stakeholders."

"This is a priceless tool for informing and engaging and building trust among all our stakeholders."

Now, the Handoff

The decision of the Wildland Fire Information and Technology Executive Board marked the conclusion of the JFSP's role in developing IFTDSS. "This has been an extremely rewarding project for us," says JFSP Director John Cissel. "Now we're handing off the working prototype of IFTDSS to the interagency community for final planning, development, and implementation. The JFSP Governing Board thanks everyone who has contributed to the design, testing, and evaluation of IFTDSS."

IFTDSS still needs a number of improvements before it can be considered fully operational. It will be managed as a beta-test version for the next 2 years, with full deployment planned for 2017. The U.S. Forest Service and the Department of the Interior are working with the Rocky Mountain Research Station's Wildland Fire Management Research Development and Applications team to outline the future planning and development of IFTDSS. It will take some time for new contracts to be put in place and for desired enhancements to be implemented, but the process has already begun.

You are invited and encouraged to become an IFTDSS beta tester. Go to the IFTDSS homepage (http://iftdss.sonomatech.com/), and request an account. Additionally, in order to help improve IFTDSS, please provide comments, suggestions, and any other input through the IFTDSS feedback link on the IFTDSS homepage. If you have questions about IFTDSS, please use the "Contact Us" link on the IFTDSS homepage.

For Further Reading

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