Decision Support Systems and the User Interface

Esteban T. Lopez

School of Information, San Jose State University

INFM 200-10: Informatics Fundamentals

Professor Jason Kaltenbacher

September 27, 2020

Decision Support Systems and the User Interface

Decision support systems (DSS) are a class of information system that do not give decisions based on data fed into formulas, but they provide information to support decision makers. The main defining concept is that a DSS is an aid and has been incorporated as a part of different types of systems (Sousa, 2014, p. 325). Exploring the iterative design of DSS and the user experience is the focus here. Designing a DSS for a decision maker requires a lot of balancing features and customizing using feedback in order to make it usable. Designers need to be cognizant of biases that might result from customization. These issues will be topically explored here. Following are a quick survey of DSS, a treatment of the nature of decisions, some literature review highlighting some DSS uses and issues, an exploration of user interaction design, and finally a conclusion.

Overview: Decision Support Systems and Decision Makers

A high-level model of a DSS is that it is composed of database management system (DBMS), a model base management system (MBMS), and a user interface (UI) (Souter, 2011, pp. 14-15). A DSS is an information system and has many of the same core features of any other information system. The key difference is the purpose of a DSS, which is to aid a user in crafting a decision. A decision maker interacts with a DSS in order to analyze and come up with a decision amongst many that are possible. A model of decision-making parallels the DBMS, MBMS, and UI components discussed above. “The decision-making process combines three major phases: intelligence, design, and choice” (Sousa, 2014, p. 350). The intelligence phase corresponds with the DBMS; this could be relevant information and data from anywhere. The design phase corresponds with the MBMS; In the decision-making process design means using models to

manipulate information. A key concept in DSS is sensitivity analysis or a what-if analysis (Sousa, 2014, pp. 334-335). The design phase and MBMS use intelligence from the DBMS to perform sensitivity analysis. Design in the context of the decision-making process should not be confused with the design of the DSS itself. The choice phase and UI do not necessarily correspond as neatly as intelligence with DBMS and design with MBMS. It corresponds in the sense that the decision maker uses the UI to explore factors before making a choice.

The decision maker interacts with the DSS using the UI. The decision maker carries out the choice phase with the aid of the DSS. “To the decision maker, the user interface *is* the DSS” (Souter, 2011, p. 215). A DSS could provide a range of established treatment choices as in a clinical decision support system (CDSS). Also, a DSS could provide clarity by showing consensus and exposing constraints in negotiation amongst different groups, or decision making between individuals of a large group in group decision support systems (GDSS). An equivalent high-level DSS model uses data management module, model management module, and dialog module (Sousa, 2011, p. 329). The UI and dialog module are interchangeable at the high-level view, but the connotation of a dialog module is aptly descriptive for GDSS and for sensitivity analysis in general. The ultimate purpose of a DSS is to aid decision makers in converging on decisions.

Decisions and Decision Makers

The types of decisions and types of decision makers vary widely. There are generally 3 types of problems: structured, unstructured, and semi-structured (Sousa, 2011, p. 327). Structured problems do not seem to be in the domain of a DSS. A DSS is meant an unstructured dynamic situation where an outcome is not known, or even the input is still constantly being updated as in a GDSS. A DSS is also meant for semi-structured problems where there are many

options with relatively known outcomes, but decisions have pros and cons to weigh; A patient CDSS would be such an example. Many people and companies evaluate strengths, weaknesses, opportunities, and threats (SWOT); this is called SWOT analysis. Problem has a negative connotation, but that is not the way to look at decisions. One view is that "opportunity and crisis decisions may be considered to form the two ends of the continuum" (Mintzberg et. al., 1976, p. 252). SWOT analysis is an example of how a state or situation can be viewed through different prisms. Unstructured problems can morph over the life of the decision-making process, recessions or strikes can change the decision-making landscape for a profitable business (Mintzberg et. al., 1976, 268-270). It is not only the decision maker that can use models to adjust sensitivity analysis, the dynamics of the real world can be impactful as well. There are many different types of problems and many different types of decision makers. Article analysis will give a flavor of the types of DSS for different decision makers and different problems.

Article Analysis

Article 1

Andrews, S. B., Bartels, S. J., Hoffman, A. S., Llewellyn-Thomas, H. A., O'Connor, A. M., Tomek, I. M., Tosteson, A. N. A., & Volk, R. J. (2014, Dec 14). Launching a virtual decision lab: development and field-testing of a web-based patient decision support research platform. *BMC Medical Informatics & Decision Making.* 2014, 14(1), 1-27. https://doi.org/10.1186/s12911-014-0112-8

Article 1 Abstract Overview

This small study explores the viability of having patients make informed treatment decisions from a home or library computer. The idea is to tailor information to patients and allow them to weigh amongst treatment options. This study aimed to compare interactive decision making against traditional non-interactive videos. It also used feedback from the subjects to iteratively modify the system. Through iterative feedback informational links were added, glossary expanded, and user boxes and buttons were enlarged. The group involved were managing knee-pain. According to the authors, patients had a "choice between nonsurgical or surgical therapies for this condition is 'preference-sensitive', in that it involves considering their informed preferences about the likelihood of risks and benefits" (Andrews et al., 2014). Even within nonsurgical or surgical options, the authors listed an array of possible options. The authors found that all patients preferred to use the system outside of the clinic. Also based on a pre-existing scoring system on how patients make decisions, the interactive system was comparable to patients who made decisions based solely on pamphlets and non-interactive videos. This study was towards building a prototype, and while the subjects were real patients it was not truly randomized. All patients (at Dartmouth-Hitchcock Medical Center) with knee pain were invited to join during the study recruitment period. They also recruited some patients online to get a more complete demographic sample. The article acknowledges the drawback in the lack of randomization, but claims the feedback based iterative prototyping development was promising.

Article 1 Assessment

This study highlights the value of quickly creating and iteratively customizing a DSS with feedback from the users. The idea of modularization and iterative development is key to any

information system, but paramount when customizing a DSS to the user with feedback. When adequate information exists, the focus on tailoring a DSS to a user is facilitated. If there are many viable options to choose from, a decision maker can make sure they explored each option given the known information in the system. The study shows that a DSS can be quickly improved with the ongoing cooperation of end users.

Article 2

Collan, M., Lo Nigro, G., Morreale, A., & Stoklasa, J. (2016, Oct 12). Uncertain outcome presentations bias decisions: experimental evidence from Finland and Italy. *Annals of Operations Research.* 2018, 268(1/2), 259-272. https://doi.org/10.1007/s10479-016-2349-3

Article 2 Abstract Overview

This study explored the way information is presented and risk taking. The authors wanted to see how rational collegiate master level business students were when making simple decisions given different presentations of the same information. The set up was deciding between a guaranteed financial return vs. taking a lottery ticket risk. According to the study, the more information a person was given, the more risk they were willing to take. They study also used master level students from Italy and Finland because they claimed they have very different political, economic, and social views. The results in Italy and Finland were similar. The study found that people make different decisions based on how the information is presented. The authors identify and claim that more information enables a cognitive bias they call illusion of control. There were 4 questions, each option had a guaranteed return as option A. Each option B showed a mean equal to the guaranteed return on option A. The first question was just a mean. The second question was a mean and range, but just numbers. The third question

was a mean and histogram. The fourth option was a mean and a continuous graph. The histogram and continuous graph had graphical presentations that skewed right. The least risk was taken on mean vs. mean, the most risk was taken on mean vs. range.

Article 2 Assessment

The 2 major takeaways from this study are the ideas of presentation of information and cognitive bias. The article claims that more information leads to illusion of control when a large range of possible outcomes are presented (Collan et al., 2016). The only critique about the article is that in the text there is an example that the mean vs. range did not have a graphical presentation in the article. Is that how it was presented to the subjects? The mean vs. range should have had a graphical box plot and would likely have skewed right as well. The high-level lessons are that how information is presented is important, and end user biases need to be accounted for. A developer's biases should also be taken into consideration.

Article 3

de Jong, M., & Mayer, I. (2004, May). Combining GDSS and Gaming for Decision Support. *Group Decision & Negotiation.* 2004, 13(3), 223-241. https://doi.org/10.1023/B:GRUP.0000031076.98581.fc

Article 3 Abstract Overview

The authors of this article studied how a Group Decision Support System (GDSS) and practicing using them using open-ended rules by multiple actors can help correct deficiencies in the GDSS. This study likened gaming with a GDSS as analogous to war gaming. The authors identified 3 values of gaming with the GDSS. The first one is for individual users to train using the GDSS. The second is to see how individuals and organizations interact with the GDSS and

how they interact with each other through the GDSS. The third value is the ability to learn what sorts of outcomes are possible and ways to tailor the GDSS. The study emphasized these happen in a safe non-critical gaming environment. The nature of the games the authors chose are public works types of simulations, where you have different agencies or a combination of private and public agencies interacting.

Article 3 Assessment

The biggest takeaway from this article using gaming to iteratively improve the design of a GDSS but could be applied to any DSS. The article goes into depth classifying a GDSS and a game. DSS's don't make decisions they are decision aids. The authors say a GDSS uses "[a]nalytical rationality" and a gaming framework uses "[s]trategic and political rationality" (p. 228). From the perspective of a DSS, they cannot be thought of as mutually exclusive. True, a DSS provides information but towards navigating an uncertain outcome. Strategic and political decisions must be counted amongst the types of decisions that have uncertain outcomes. Another relevant takeaway is using the DSS for practicing and learning how to interact with others in the case of a GDSS.

Article 4

Ackerman, F., & Eden, C. (2014, Nov). 'Joined-Up' Policy-Making: Group Decision and Negotiation Practice. *Group Decision & Negotiation.* 2014, 23(6). 1385-1401. https://doi.org/10.1007/s10726-013-9375-1

Article 4 Abstract Overview

This study explored how individual multi-department organizations make goals and how to use a GDSS to help two different organizations find common ground. They studied

organizations centered around hospitals. They also studied the responsibilities between utility companies and regulators. The authors listed categories of goals. Basically, the goals are either unique to an organization that an organization can handle themselves or the goals need cooperation between organizations to be realized. The goals also had to be anonymous to avoid group think. The subjects of the study found that by having organizations use the GDSS, the starting point of negotiations took hours rather than months. Personalities do not have a way to dominate over the collaborative negotiation process. The feedback from the subjects of the study claimed, “the role of the GDSS with respect to anonymity, productivity, and causal mapping for structuring” helped speed up negotiations (p. 1399).

Article 4 Assessment

The key takeaway is to use a GDSS identify goals. Using the goals explore common grounds and differences for negotiation. A bonus is taking personalities out of the picture, at least for the groundwork. The study could have focused on one case study in-depth. It went through 3 cases. The article was illustrative, but more detail of a single case study would have been welcome. The concepts provided by the article are great. They should be explored in the context of political deliberations, or any sort of deliberative process where personalities and ideas seem to be at cross-purposes. Most articles that bring up the subject of modifying a DSS, it is aimed at the end user. The concepts in this article support the idea of tailoring a DSS to a purpose, in this case to facilitate negotiations.

User Interface Design and Decision Makers

While all information systems need a good DBMS and MBMS, they all benefit from having a user-friendly interface. Marketing might make stylizing a UI beneficial for customer

influence, a DSS needs to be customized for the sole purpose of adapting to the decision-maker. One design concept of a DSS is that in order to be effective needs to be usable: usability. A study of an emergency room CDSS prototype was shown to be too complicated and had far too many options for both clinicians and patients (Abujard et. al., 2017). Even though a DSS can be thorough, thoroughness can be a hindrance. “Revisions dramatically reduced the number of screen taps, checkboxes, and data entry”, but decision-makers could expand choices on the DSS as needed (Abujard et. al., 2017). This could be akin to a key performance indicator (KPI) dashboard, where high-level information is provided and could be drilled into if needed. A good DSS design keeps the UI simple, but amply capable to handle different or more detailed information request and handling. In the article analysis above, article I showed that patients wanted more features added to their interface (Andrews et. al., 2014). One situation was an emergency room and the other was patients in the comfort of their home. The environment and urgency of a situation are probably a factor. The difficult part is striking a balance between information overload and inadequate information for decision-makers. Prototyping and iterative improvement relative to user preference is important.

The emergency room CDSS is for practicing clinicians as well as random patients. Thankfully, specific patients do not get extensive training in the emergency room. This next example is principally sound, but hopefully the decision-makers here do not need it in the real world too much. The RAND Corporation suggests military DSS decision makers should be extensively trained and involved in design (Enger et. al., 2005, pp. 86-87). Having the actual users involved in the early stages of DSS design has the triple benefits of customizing the UI to

the decision makers preference, getting decision makers to accept and embrace the DSS, and extensive training and familiarity with the DSS.

Customizing a DSS to user's preference is ideal, but there are some issues that need to be managed. One broad issue is bias in many forms. A study where users customized a DSS for predicting baseball scores showed that decision makers preferred results that matched their customized model versus other valid models, the explanation is confirmation bias (Solomon, 2014, p. 3072). This is one bias in a family of confidence biases called confidence bias, two other biases in the family are called completeness bias and illusion of control bias (Enger et. al., 2005, p. 15). Preferences are usually what people are used to and know, this leads to bias and dismissal of viable alternatives. "This view of decision making is sometimes called the *heuristics bias paradigm* (HPB)" (Enger et. al., 2005, p. 15). There are plenty of biases to account for when designing and customizing a UI for DSS. While this is not about artificial intelligence (A.I.), there are examples where bias and heuristics can be limiting. An example is TD-Gammon, if one is inclined to read about neural networks. TD-Gammon is a program that learned to play backgammon and, "the program has come up with genuinely novel strategies that actually improve on the way top humans usually play" (Tesauro, 1995, p. 62). Experts usually have good practices and heuristics that help them succeed and make decisions with good results. Even though experts can have a good system, they should be open to sensitivity analysis and alternate models.

Conclusion

Decision support systems (DSS) are meant to aid decision makers toward a decision from an unstructured problem, but not to provide the decision. There are many different types

of decisions and possible actions to take. The types of decision makers vary as well. They can be patients or doctors, business negotiators, military, emergency responders, and fantasy sports managers. Various DSS models have many synonymous features, even if they have different names. They all have data/information component, an algorithm/modeling component, and a user interface (UI) component. Since a DSS does not formulaically output a structured decision, it requires a decision maker or user. While the whole DSS is important, customizing the UI for decision makers is as major an area as creating databases and models. Studies and user feedback have shown that there is a balance in creating a DSS UI. The UI can be overdesigned and overwhelming to use, or it can be too minimal and lacking in features. In order to get decision makers to appreciate the DSS, they should be involved in the iterative design and trained early on. Feedback is necessary to render the DSS usable by customizing the UI. A danger in customizing to very specific preferences, is bias. A decision maker might not really consider all the options using sensitivity analysis. The decision maker is in danger of relying on confirmation biases, rather than fully considering all the options. This is the nature of dealing with unstructured problems, there is no defined set of algorithms or approaches to make a dynamic choice. DSS are promising so long as they are understood as aids to some human expertise or interest.

References

Abujarad, F., Breslin, M., Guo, G., Hess, E.P., Lopez, K., Melnick, E.R., Pavlo, A.J., Post, L.A., & Powsner, S.M. (2017, May). Patient-Centered Decision Support: Formative Usability Evaluation of Integrated Clinical Decision Aid for Minor Head Injury in the Emergency Department. *Journal of Medical Internet Research.* 2017, 19(5), 1. https://doi.org/10.2196/jmir.7846

Ackerman, F., & Eden, C. (2014, Nov). 'Joined-Up' Policy-Making: Group Decision and Negotiation Practice. *Group Decision & Negotiation.* 2014, 23(6), 1385-1401. https://doi.org/10.1007/s10726-013-9375-1

Andrews, S. B., Bartels, S. J., Hoffman, A. S., Llewellyn-Thomas, H. A., O'Connor, A. M., Tomek, I. M., Tosteson, A. N. A., & Volk, R. J. (2014, Dec 14). Launching a virtual decision lab: development and field-testing of a web-based patient decision support research platform. *BMC Medical Informatics & Decision Making.* 2014, 14(1), 1-27. https://doi.org/10.1186/s12911-014-0112-8

Collan, M., Lo Nigro, G., Morreale, A., & Stoklasa, J. (2016, Oct 12). Uncertain outcome presentations bias decisions: experimental evidence from Finland and Italy. *Annals of Operations Research.* 2018, 268(1/2), 259-272. https://doi.org/10.1007/s10479-016-2349-3

de Jong, M., & Mayer, I. (2004, May). Combining GDSS and Gaming for Decision Support. *Group Decision & Negotiation.* 2004, 13(3), 223-241. https://doi.org/10.1023/B:GRUP.0000031076.98581.fc

Enger, M., Kulick, J., & Paul, D.K. (2005). *Implications of Modern Decision Science for Military Decision-Support Systems.* Retrieved on September 10, 2020, from https://ebookcentral.proquest.com/lib/sjsu/reader.action?docID=784078

Mintzberg, H., Raisinghani, D., & Theoret, A. (1976, Jun). The Structure of 'Unstructured' Decision Processes. *Administrative Science Quarterly.* 1976, 21(2), 246-275. https://doi.org/10.2307/2392045

Solomon, J. (2014, Apr 26). Customization bias in decision support systems. *Proceedings of the SIGCHI Conference on human factors in computing systems.* 2014, 3065-3074. https://doi.org/10.1145/2556288.2557211

Sousa, K.J., & Oz, E. (2015). *Management Information Systems* (7th Ed.). [Kindle Fire HD 10 (9th generation)]. Retrieved on August 24, 2020, from https://www.amazon.com

Souter, V.L. (2011). *Decision support systems for business intelligence* (2nd Ed.). Retrieved on September 13, 2020, from https://learning.oreilly.com/library/view/decision-support-systems/9780470433744/

Tesauro, G. (1995, Mar 1). Temporal difference learning and TD-Gammon. *Communications of ACM.* 1995, 38(3), 58-68. https://doi.org/10.1145/203330.203343