6.6 THE IMPORTANCE OF THE PROVIDER-USER RELATIONSHIP AS PART OF AN UNDERGRADUATE METEOROLOGY CAPSTONE COURSE

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1. INTRODUCTION

At the 2008 symposium, I presented the idea of using a business process model as an organizing construct for a senior-level weather forecasting course taught to meteorology majors at Embry-Riddle's Daytona Beach, FL campus (Lanicci, 2008). Subsequently, it was suggested I publish this piece in the Bulletin of the AMS, which happened four years later (Lanicci, 2012). Now I am teaching the capstone that follows the forecasting course, and once again using the business process model, but in a different way.

This paper begins with a short background on the capstone course and a summary of the business process model. It then discusses how the model is applied throughout the course by means of three different concepts: 1) a User (and Provider) Identification Table, 2) a concept I call the User's Mission Space diagram, and 3) the Weather Risk Management Association's six-step process for determining weather/climate information requirements for a given customer (http://www.wrma.org). These three concepts are used with the business process model throughout the course, and are applied by the students in their final projects. I will close by presenting an example of one of the projects, followed by conclusions.

2. CAPSTONE COURSE AND WIPC/PUR MODEL

The Operational Meteorology Seminar (WX 442) is the culminating course for the B.S. in Operational Meteorology. The course is geared towards students who will enter the workforce primarily in User support functions such as airline flight dispatcher, but also includes a number of broadcast meteorology students. The course description for WX 442 states that the following topics are covered: 1) operational weather support; 2) customer requirements analysis; 3) defining support methodologies; 4) ethical principles; 5) data collection and analysis; 6) weather product tailoring; 7) dissemination strategies; 8) quality assessments; and 9) product refinement. Prerequisites include Physical Meteorology, Applied Climatology, Business Statistics or Meteorological Statistics, and the corequisite is Advanced Weather Forecasting (Embry-Riddle Aeronautical University, 2015).

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Figure 1 displays the latest version of the business process model used in this course. The top tier represents the national meteorological/hydrological services' (NMHS) production cycle, which I emphasized when I taught the forecasting class. Note that for teaching purposes, I highlight that the first three modules of the WIPC are 'owned' by the NMHS, while the private sector typically 'owns' the last three. This distinction is used as a jumping-off point for class discussions about the roles of the public vs. private sectors, and how/where conflicts can occur. The second tier is focused on the Provider-User Relationship (PUR), and I will highlight the ways in which we cover the portions of this part of the model.

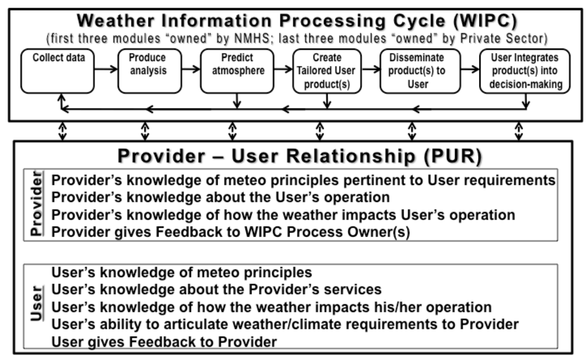

Figure 1. Weather Information Processing Cycle (WIPC) and Provider-User Relationship (PUR) adapted from Lanicci (2012). The top 'tier' represents the traditional production cycle as executed by the NMHS and the private sector. The bottom tier represents the Provider-User Relationship, which, along with the last three modules of the WIPC, forms the foundation of the present course.

3. APPLYING THE MODEL IN WX 442

In the course, we cover various aspects of weather/climate sensitivity in the transportation, insurance/reinsurance, agricultural, and energy sectors. These ideas are reinforced through lab exercises on each of these sectors, which in turn allows students to learn how to apply the WIPC/PUR concepts, which is a requirement for their final projects. I will now describe each step of the PUR process as it is covered in class.

In the first part of WX 442, I discuss the types of knowledge beyond the foundational meteorology courses that are necessary in order to be an effective

Provider of weather/climate information to a diverse community of Users. In this segment, topics include different methods of applying climatology, and examples of local effects and phenomenology.

The next part of the course is concerned with proper understanding of the User's operation, and how to evaluate the degree of meteorological knowledge that the User possesses. The User's knowledge can be evaluated by means of a template that attempts to categorize a User in terms of weather/climate knowledge, information sources, degree of weather salience (e.g., Stewart, 2009; Stewart et al., 2012), and approach to weather/climate problems in their business operations. Table 1 shows the user identification table employed in this course. Categories of User were derived from review of public health literature, which uses the terms "lay" and "expert" in its writings (e.g., McClean and Shaw, 2005), and the sociology literature, which discusses the interactions between scientists and non-scientists (e.g., Turner, 2007). The category "Amateur Practitioner" came about due to the need to capture those Users who actually perform some elementary weather duties (e.g., cooperative observer, storm spotter); this was intended to distinguish the amateur practitioner from the lay expert. The term *salience* is being used here in a slightly different context than that posed by Stewart (2009). Here, it means an interest in the weather, for its own sake, and/or because of the User's line of work. Note that the right three columns include a categorization of the Provider. I believe it is important for Providers to get an understanding of where they fit, in addition to evaluating their User.

	Lay person	Lay "expert"	Amateur practitioner	"Novice" practitioner	"Journeyman" practitioner	"Expert" practitioner
Professional	No	No	No	Yes	Yes	Yes
Level	None	None	None	Entry	Mid-level	Senior-level
Knowledge base	None to some experiential	Experiential, some course(s)/ training	Experiential, some course(s)/ training; could also be coop observer, storm spotter	Basic formal education & training; none to experiential	Advanced formal education & training; experiential	Advanced formal education & training; experiential
Information source(s)	None, media[1], social networks[2]	Media[1], social networks[2], lay pubs	Media[1], social networks[2], lay pubs	Media[1], scholarly pubs, lay pubs, social networks[2]	Media[1], scholarly pubs, lay pubs, social networks[2]	Media[1], scholarly pubs, lay pubs, social networks[2]
Salience	None to some	Yes	Yes	Yes	Yes	Yes
Approach to weather / climate problems	Reliance on media[1], social networks[2], providers	Reliance on intuition, providers, media[1], social networks[2]	Reliance on intuition, providers, media[1], social networks[2]	Reliance on knowledge, advice of sr. practitioners, media[1]	Reliance on knowledge, experience, advice of colleagues/sr. practitioners, media[1]	Reliance on knowledge, experience, advice of colleagues, media[1]

1 – Media refers to TV/radio and electronic (e.g., Internet weather web sites).
2 – Social networks refer to formal, informal, and electronic (e.g., Facebook™, Twitter™).

Table 1. User-Provider Identification Table.

The category of Information source(s) in Table 1 bears some further discussion. I instruct students that the User's idea of a trusted information source may depend to a great extent on the User's social network, which is defined as "a set of relations, links, or ties among social actors." (Persell, 2008). A Provider needs to be aware of the User's social network because of the differing levels of trust that people place in different groups. In this context, I introduce the students to the concepts of *bonding ties* and *bridging ties*. Bonding ties refers to social networks between socially homogenous groups, while bridging ties are social networks between socially heterogeneous groups (World Bank, 2010). This distinction becomes important when one considers that people may be more trusting of their bonding ties than their bridging ties, which in turn may influence their trusted source(s) of information on many topics, including weather and climate. This point is especially true if a User has never used a weather consulting firm in the past and believes that he/she can "figure it out" for themselves.

The examination of the User from the Identification Table is a good segue into the next step in the PUR, which examines the degree to which the Provider understands his/her User's operation, and whether the User understands how weather/climate can impact business operations. In this step, I provide a tool for the students to use in order to help answer these questions. The tool is called a Mission Space Diagram, and asks the students to determine which types of 'mission types' their User's business falls into regarding their use of weather and climate information. The mission space diagram is shown in Figure 2, and contains the following categories of User missions: 1) Resource Protection, 2) Risk Mitigation, and 3) Exploitation.

The definitions of these categories are presented below:

Resource Protection. Safeguarding people, equipment, facilities from harsh weather and climatic conditions.

Risk Mitigation. Sustained action that reduces or eliminates long-term risk to people and property from natural hazards and their effects. This is a FEMA-based definition that includes both extreme weather events and climatic anomalies.

Weather Exploitation. In a military context, Lanicci (1998) defined exploitation as "the deliberate use of knowledge about friendly and enemy operating capabilities under given natural environmental conditions to set the terms of battle, resulting in optimal performance of the friendly force and reduced effectiveness of the enemy force."

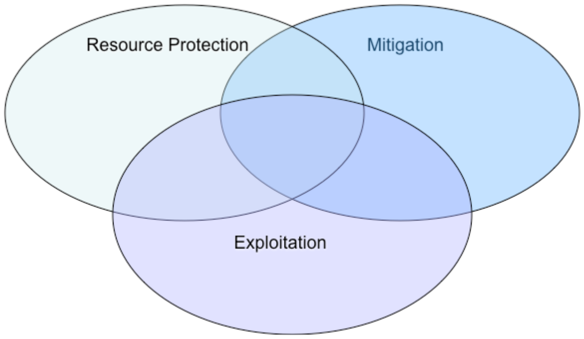

Figure 2. User mission spaces shown as a Venn diagram.

After introducing the diagram, I provide several examples of each mission category, and discuss them with the class. For a good example of resource protection, I present the National Weather Service (NWS) Mission Statement, which is “Provide weather, water, and climate data, forecasts and warnings for the protection of life and property and enhancement of the national economy.” (NWS, n.d.). I ask the class if the portion of the mission statement “enhancement of the national economy” is truly a Resource Protection mission. This leads us into further discussion of the public/private sector relationship, which is an important issue for the profession (National Research Council, 2003; NOAA, n.d.). I emphasize that Risk Mitigation is more of a long-term commitment to reduce exposure to extremes in weather and climate. I then provide an example of risk mitigation by introducing them to the concept of a weather derivative. The students have an opportunity to explore the weather derivative later in the semester through a lab exercise. While weather exploitation could be considered a relatively new mission, there are historical examples such as the D-Day forecast (Fleming, 2004; Bates, 2010). In class, I show both military and civilian examples of exploitation in order to explain the concept and illustrate how there can be overlaps among the three areas.

The final portion of the PUR covers feedback from Provider to the NMHS, or from the User to the Provider. In the former, I introduce the students to the various forms of forecast verification that can be used, such as Mean Absolute Error, Root Mean Square Error, Anomaly Correlation, Brier Score and Brier Skill Score. We employ Mean Absolute Error, Brier and Brier Skill Scores in a forecasting value-added exercise during the semester. For the User-Provider feedback the students are introduced to the concept of value added by means of contingency tables and Cost-Loss Ratio (see ECMWF, 2015, for a thorough explanation and discussion of Cost-Loss Ratio).

4. STUDENT FINAL PROJECTS

Students are required to develop a business proposal for a weather/climate product or suite of products for an actual User with whom they are required to make contact and meet several times throughout the semester to gather and finalize product requirements. The students are asked to categorize the User’s knowledge using Table 1, and their business operations using Figure 2. In order to provide them with a useful organizing template, I adapted the Weather Risk Management Association’s (WRMA) Steps for Weather Risk Management for Buyers with Natural Exposures to Weather (WRMA, n.d.). For convenience, these are listed below:

1. Identify the critical weather variable or variables.
2. Identify the impact of the weather variables on revenues, margins, profits and/or costs.
3. Identify a reliable, neutral source of historical data and current recordings of the weather variables (usually a government agency such as the National Weather Service in the U. S., MeteoFrance or the Japan Meteorological Agency).
4. Identify the date period during which the weather variables’ influence is operative (e.g. hot weather influences air conditioning use primarily in the summer).
5. Quantify the relationship between changes in the weather variables and changes in the financial parameter affected by weather.
6. Establish sensitivity to the changes in the financial parameter and translate the sensitivity into terms of the weather variable.

I make it very clear to the students that realistically, they can expect to make it through step 4, and that it is unlikely that they will be able to collect financial data from the User in order to accomplish steps 5 and 6. If they can at least make some qualitative estimates of the relationship between critical weather/climate parameter(s) and User financial performance, that would demonstrate their understanding of these concepts and an ability to apply them to a client. The beginning stages of the final project are usually the most difficult for the students. Some people are very open to talking with students about their operations, while others do not even return phone calls or answer emails. But once the students have established that relationship, it is very rewarding to see how the relationship develops and “watch the light bulbs start coming on” as students begin making connections among the various concepts covered in the course.

Table 2 illustrates an example of one type of User sensitivity analysis that is typically performed by students in their final projects. In this example, a local golf course has identified several important weather parameters and their critical thresholds for action.

This list of critical weather parameters from a local golf course was determined through meetings between the student team and the golf course management.

10 consecutive days of rain with soil high temperatures over 86°F	Formation of black mold is likely under layers of Bermuda grass, mole cricket breeding is possible, and irrigation overflow drowns nearby grass and loses the course money.
Thunderstorm producing over 0.5" in a single event	Irrigation overflow is likely, which will drown nearby grass and cost the course money in lost water and grass to possibly replace.
T > 100 °F	Grass begins to die regardless of fertilizer, less water is recommended
T > 86°F to ≤100°F	Heat resistant fertilizer is recommended to keep the green lively
T ≥ 50°F to ≤ 86°F	Optimal temperature for Bermuda Grass, only watering and basic fertilizer are required
T = 32°F to < 50°F	Fertilizer which sinks deeper into the soil is required to keep cold grass healthy
T < 32°F	Grass begins to wither due to frost and soil hardens providing a poor surface for players

Table 2. User Sensitivity Table.

5. CONCLUSIONS

I have taught this course for three years at Embry-Riddle, and generally speaking, the student evaluations have been very positive. Table 3 shows a compilation of student course evaluations over the last three years, totaling 31 students. In the table, the rating scales are 4 = Strongly Agree; 3 = Agree; 2 = Disagree; 1 = Strongly Disagree.

Categories	Rating (4-pt scale)
Clarity of Presentation	3.71 ± 0.10
Content, Structure & Organization of the Course	3.54 ± 0.18
Learning Outcomes	3.66 ± 0.10
Students/Instructor Interaction	3.77 ± 0.09
Number of students (four semesters)	31

Table 3. Summary data from Course Evaluations.

Verbal comments from the course evaluations and received informally throughout the semester from individual students have been very positive. Most students understand the reasons for the complex lab exercises used to illustrate how conventional weather and climate information undergoes a transformation into impact parameters that a User can understand and employ in their daily activities. On the down side, some students got "lost in the spreadsheets" and were not able to totally comprehend the reasons for doing the exercises. I have been working diligently on revising these exercises each semester in order to make them more comprehensible to the students.

To summarize, use of the WIPC/PUR business process model in an undergraduate capstone course has been successful. In addition to providing an organizing concept for the course, the model helps the students "translate" familiar meteorological concepts into less-familiar, user-focused, tailored weather/climate information. Additionally, the WIPC/PUR model serves as a focal point during final project development and completion by providing students with a set of specific procedures to follow when dealing with actual Users of weather and/or climate information. The User Identification Table, User Mission Space Diagram, and WRMA six steps, taken together with the WIPC/PUR model, provide a stable and understandable framework for preparing second semester seniors for the challenges they will face upon entering the rapidly changing business environment in operational meteorology.

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