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Integrating a Multi-Disciplinary Program Using Concept Mapping

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Abstract

The technique of concept mapping was used in the design and development of two new courses in Service Systems Engineering. Service System Engineering spans across multiple disciplines within engineering, sciences, and business so the concept mapping was a particularly useful activity. Concept mapping identified purposeful overlaps, eliminated significant redundancy,

and identified building blocks between courses. It also aided in ensuring programmatic objectives were achieved throughout the entire curriculum. As a result of identifying concept mapping as a powerful tool for curriculum integration, the next step in the concept mapping process will be to look at all the other courses in the degree program and expand the concept map so that it is more comprehensive. This paper outlines the process, discusses resultant modifications to the curriculum, and provides a sample of the concept map.

Introduction

Bloom (1956) identifies evaluation and synthesis of knowledge as high levels of cognitive performance. Bloom's taxonomy of learning allows for a building block approach to learning, thereby promoting longer retention of concepts covered in course materials. This is critical when prior learning is necessary for advanced or follow-on course work (Johnson, 2005), thus closely related courses must be planned carefully. Concept mapping is an effective planning tool for instruction (Grayson H. Walker TRC, 1998). Concept mapping is an easy way to encourage high levels of cognitive performance, when the process is well done (Novak and Cañas, 2008).

The parking lot approach was a part of the concept mapping process used to understand the concepts to be covered, allocate the topics between courses, and as a starting point to the concept mapping process. The list of topics was collected in a parking lot, which is a temporary repository for concepts before their best fit is determined (Novak and Cañas, 2008). The concept mapping process began by allocating the topics for the two courses, Introduction to Service Systems Engineering (SSE-INTRO) and Service System Operations (SSE-OPS). This was followed by developing individual concept maps. The individual content maps were developed with the underlying program and course objectives being kept in balance as the maps evolved.

Finally, the linkages between the two courses' concept maps were noted. This allowed for a profound understanding of the prerequisites, purposeful redundancies, and concept relationships.

Overview of Concept Mapping

Concept maps are an effective means of representing and communicating knowledge (Cañas, et. al, 2004). Concept maps enable users to graphically depict their understanding of a domain of knowledge (Cañas, et. al, 2004; Novak and Cañas, 2008). A way to define the context for a concept map is to construct specific objectives that allow for the concept maps to be focused. The concept maps can be created by the instructor designing and developing the course. They can also be constructed by students so that they gain an understanding of the relationships between the different concepts and topics covered in a course or curriculum.

Concept maps are a working tool that allows for responsiveness to change in a fluid and dynamic knowledge environment. They can take on several different structures. The most common format for a concept map is a tree structure. Another form that is used is a cyclic approach. Either form allows for linkages between different concepts.

Prior to developing the concept map, it is helpful to use brainstorming to identify the specific concepts that should be included in a course or multiple courses within a curriculum. The "parking lot" services as a place to capture the concepts.

Parking Lot

The parking lot is used for many different reasons. When conducting training or course sessions, it can be used to capture unanswered questions. It can also be used to capture information generated through brainstorming. The parking lot technique is a list of concepts waiting to be

added to a concept map. The starting point for construction of the concept map can be a list of concepts brainstormed by the curriculum development team (Novak and Cañas, 2008). Reviewing the list of concepts and using affinity diagrams assists in grouping like concepts together. This also allows for translation of information into meaningful course objectives that would then need to be confirmed with the overall program objectives to ensure congruency.

Program Objectives

The program objectives served as the macro level for the development of the concept maps. The different topics in the parking lot were then grouped to better drive the proposed course objectives. The proposed course objectives were then compared to the program objectives to make sure they were aligned. Once this step occurred, the course content and concept maps were developed.

The program objectives for the Service Systems Engineering curriculum are:

1. A sound technical foundation with a Service Systems Engineering focus and the flexibility to pursue professional interests in areas outside of engineering that could lead to a wide variety of career paths.
2. In-depth technical preparation in Service Systems Engineering that could serve as a springboard to professional degree programs such as the Master of Engineering.
3. The knowledge, skills, and attitudes needed to facilitate a lifetime of professional success. These attributes would include excellent communication skills, an understanding of ethical and global issues, and a commitment to life-long learning and professional development.
4. The ability to function on multidisciplinary teams that extend the traditional boundaries

of engineering.

5. The ability to design and improve systems and processes that provide services by applying a system perspective coupled with a thorough understanding of the customer.

The parking lot of concepts and the program objectives were used in collaboration to develop the course of objectives for the Introduction to Service Systems Engineering and Service System Operations.

Course Objectives

The Introduction to Service Systems Engineering objectives include:

a) appreciation of the service systems engineering discipline;
b) application of problem-solving techniques to systems problems that involve human-based uncertainties;
c) understanding the scope and importance of the service industry and an appreciation of the differences between manufacturing pre-production and service co-production (co-creation);
d) developing a service system, critiquing it, and developing ideas for improving it; and
e) applying systems engineering design and analysis techniques. The Introduction course serves as the foundation for the rest of the curriculum.

It has greater linkages to the Service System Operations course than it does to other courses in the curriculum. Hence, the discussion of these two courses together in the development of the concept maps.

The Service System Operations course was designed and developed to provide the foundation in several areas:

a) Describe the operations function in service and manufacturing firms.
b) Integrate service system operations with other disciplines.
c) Apply specific operational tools and techniques, including quantitative and qualitative, to make more informed decisions.
d) Provide solutions to real-life service systems problems through analysis, evaluation, and selection of solutions.

Service System Operations course is a survey course introducing major concepts and techniques used to manage the service system operations function. The course considers both managerial and analytical issues, since an effective decision-maker must be proficient in both areas.

Matching Program and Course Objectives – Service System Operations

As indicated earlier, another important aspect of concept mapping is to ensure that the program and course objectives are congruent. This was done for both courses. An example is provided for the Service System Operations course. Each letter indicates a course objective and in parenthesis is the corresponding program objective.

a) Describe the operations function in service and manufacturing firms. [1, 3]
b) Integrate service system operations with other disciplines. [1, 3, 5]
c) Apply specific operational tools and techniques, including quantitative and qualitative, to make more informed decisions. [1, 2, 3, 4, 5]
d) Provide solutions to real-life service systems problems through analysis, evaluation, and selection of solutions. [3, 4, 5]

In some courses it is possible that not all program objectives can be achieved. In the Service System Operations course there are several opportunities for achieving most of the program

objectives as noted in our example.

The next step is to develop the concept maps into expert skeletons from the same topics in the parking lot.

Application - Concept Maps

The major components of the concept maps for SSE-INTRO and SSE-OPS are presented below.

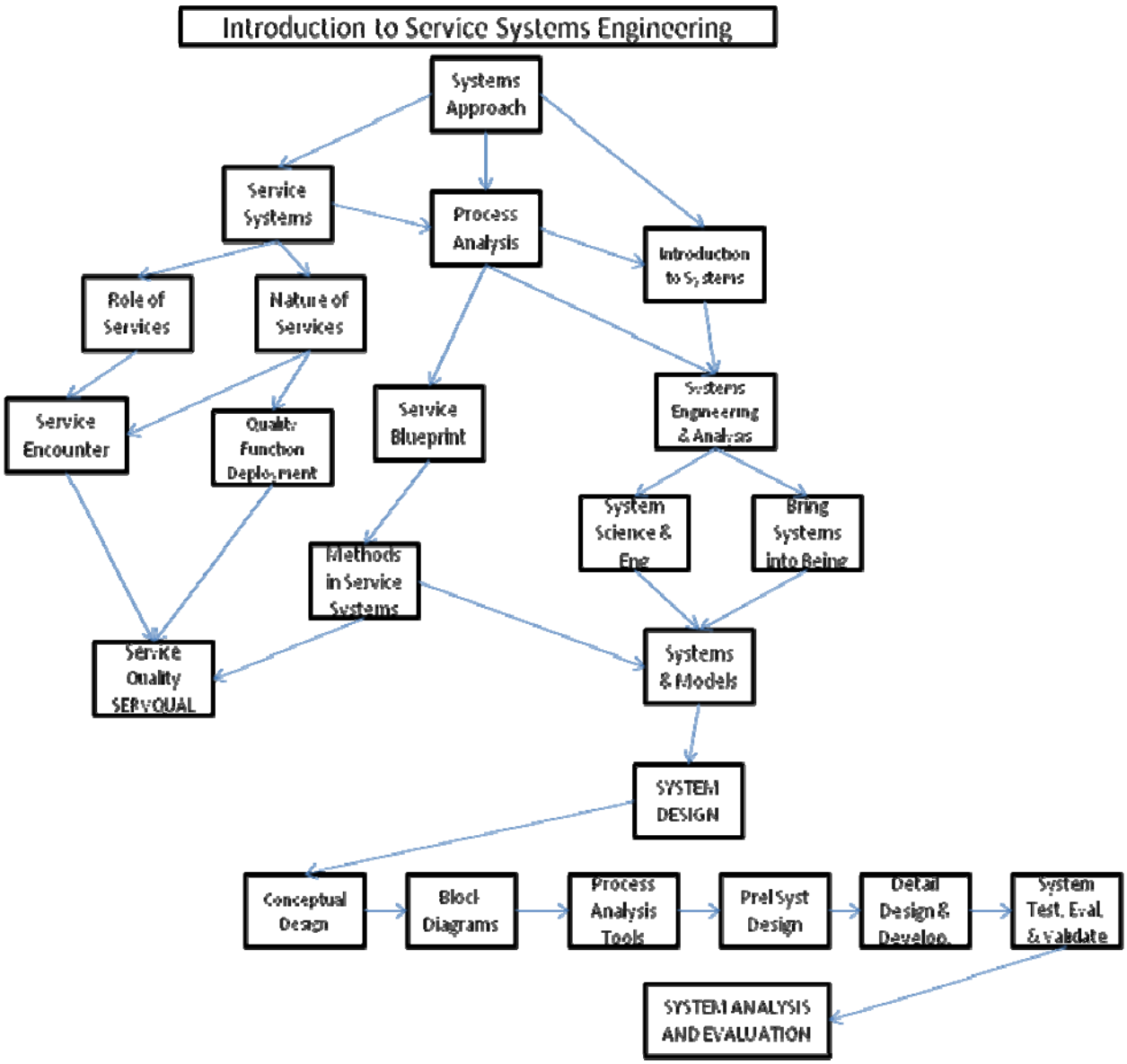

Figure 1: Concept Map – Introduction to Service Systems Engineering

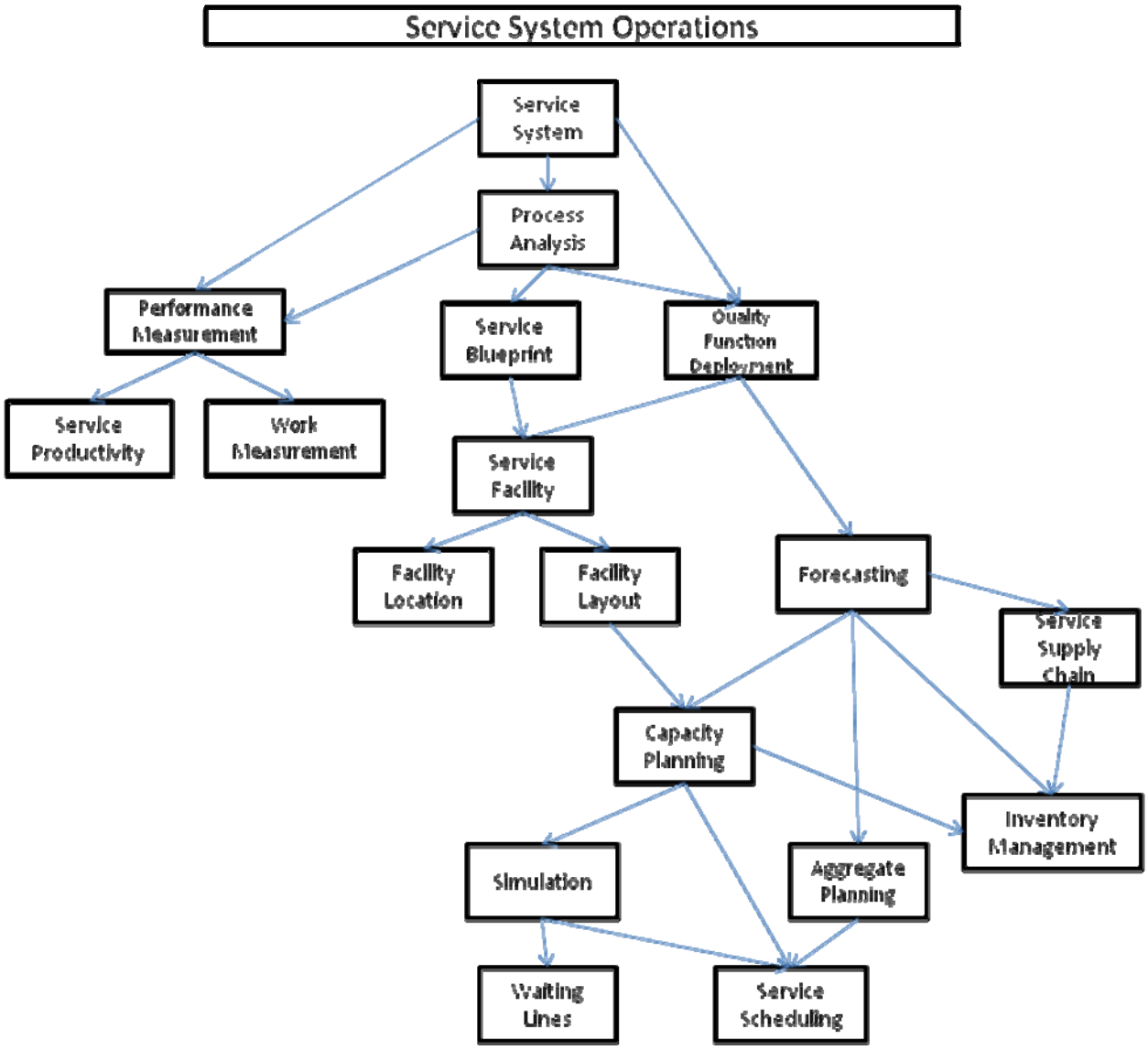

Figure 2: Concept Map – Service System Operations

These are macro level concept maps of each of the two courses. It is recognized that some of the boxes in the concept maps could be used more than once. For example in Figure 2, Service System Operations, performance measurements are implicit in each of the different topics throughout the entire course but were not noted for each instance.

The key linkages between the two courses are visually depicted in Figure 3. Again, this gives the macro level detail of the integration of these two courses. The links are shown by the

similarity of the boxes in the two different courses.

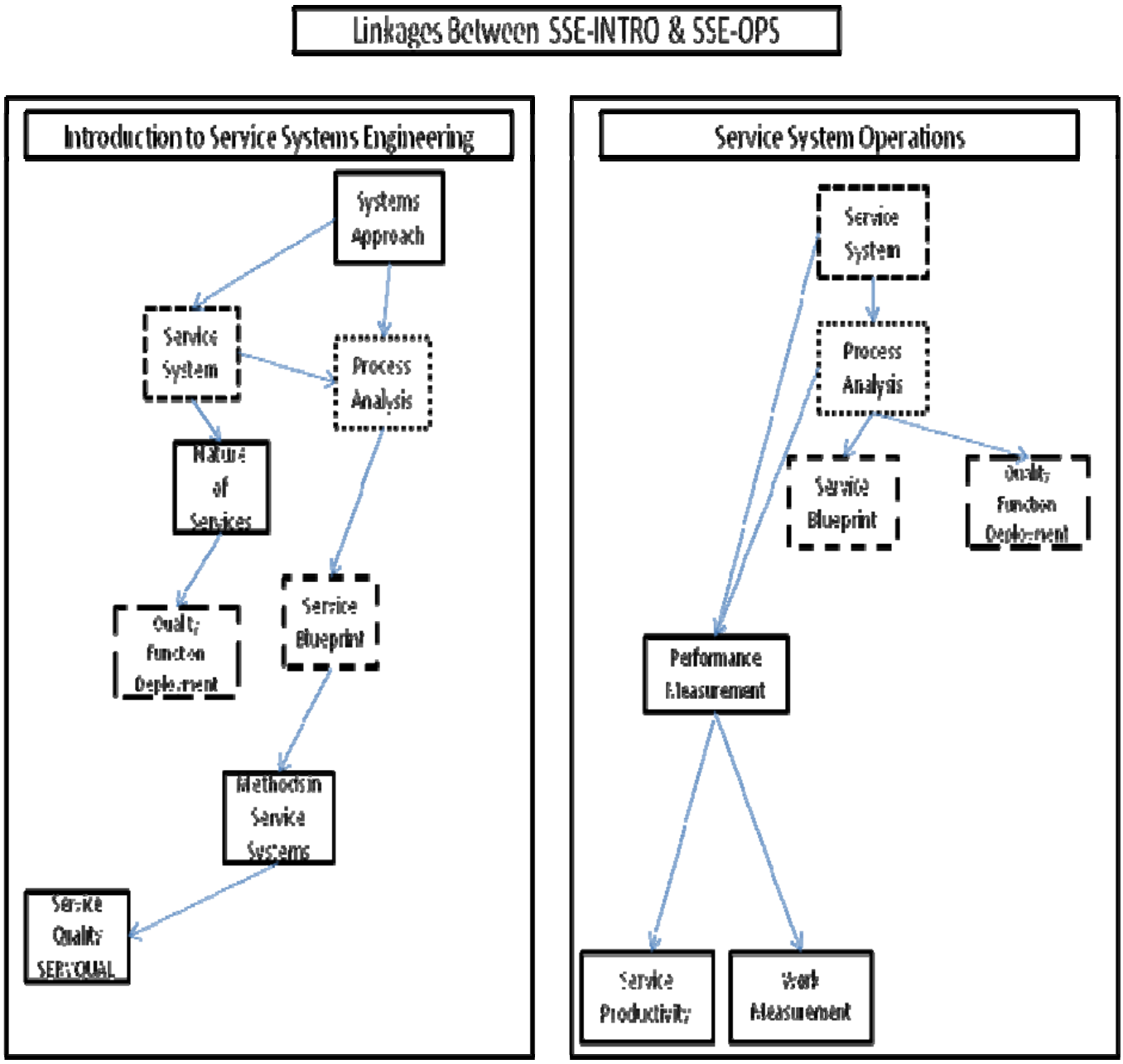

Figure 3: Partial Links Between Courses

Lessons Learned

The concept mapping exercise was used in the development of two courses. This was a useful process to understand the relationships between the two courses, evenly distributing the content,

and develop of exercises and activities for each of the courses. It would have been helpful from the inception of the curriculum development process to look at all courses while they were being developed. Several courses were developed concurrently and the last two courses development is close to completion.

Next Steps

As the curriculum team begins to move forward with the review and assessment of the program and the curriculum, as a part of the continuous improvement process, each course should have a content map and the content maps should be linked to each of the related courses in the curriculum, similar to the two courses demonstrated in this paper. It will also allow for refinement of course content and associated assignments for each of the courses. This will allow for a more cohesive and integrated curriculum. As a part of the continuous improvement activities associated with the Service Systems Engineering curriculum, we will construct a global "macro map" showing the major ideas for the entire curriculum, which would represent an expansion of the work completed for the two courses discussed in this paper.

Conclusion

In curriculum planning, concept maps are quite useful. "They present in a highly concise manner the key concepts and principles to be taught. The hierarchical organization of concept maps suggests more optimal sequencing of instructional material. Since the fundamental characteristic of meaningful learning is integration of new knowledge with the learner's previous concepts, proceeding from the more general, more inclusive concepts to the more specific information serves to encourage and enhance meaningful learning (Novak and Cañas, 2008)."

Using concept maps allows for transparency of instruction of courses throughout the curriculum. It could be helpful to map not only the Service Systems Engineering courses, but all the courses required for a student to complete the Bachelor of Science in Engineering. This would provide a comprehensive approach for continuous improvement of other courses required by students.

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