



**SOUTH DAKOTA BOARD OF REGENTS
ACADEMIC AFFAIRS FORMS**

Intent to Plan for a New Program

UNIVERSITY:	DSU and SDSU
DEGREE(S) AND TITLE OF PROGRAM:	M.S. in Software Engineering
INTENDED DATE OF IMPLEMENTATION:	Fall 2019

University Approval

To the Board of Regents and the Executive Director: I certify that I have read this intent to plan, that I believe it to be accurate, and that it has been evaluated and approved as provided by university policy.

President of the University, Dakota State University

8/20/2018

Date

President of the University, South Dakota State University

1/10/2019

Date

1. What is the general nature/purpose of the proposed program?

Software engineering is the systematic development and application of techniques leading to the creation of correct and reliable software.¹ It has also been defined as “The application of a systematic, disciplined, quantifiable approach to the development, operation and maintenance of software.”² The purpose of the proposed M.S. degree in Software Engineering is to provide highly skilled graduates who meet the needs of businesses and organizations in designing and testing software as well as providing leadership in software companies and related entities. Software engineering is a rapidly changing field; most software engineers continue to learn on the job, as languages and development environments evolve. To be sure, there are many layers of computer software, and each requires a specialist in languages specific to that layer. The computer science discipline and the market demand has shifted to include a much greater demand for software engineering.

Most software engineers specialize in a few areas of development, such as networks, operating systems, databases or applications, and each area requires fluency in its own set of computer languages and development environments. Also, most software engineers collaborate with other specialists in development groups all working together to create complex projects.

¹ Software engineering description at University of Strathclyde, Glasgow, Scotland.

² IEEE Standard Glossary of Software Engineering terminology

Educational requirements for software engineers include at least a bachelor's degree in software, math or science, as well as broad experience with computer systems and applications. Larger companies, or organizations with unique or proprietary development platforms, typically provide training for new employees. Commonly required skills include strong analytical skills and the ability to pay careful attention to detail, as well as the capacity to work well in groups and a willingness to understand the various roles played by fellow team members. Knowledge about the subject area in which they are working, or the intended audience, is valuable.³

DSU and SDSU are proposing to create an academic degree in software engineering at the Master of Science (M.S.) level. Responding to the national need for professionals in computer science, computer network development and web development for public and private organizations, the proposed masters' degree will produce individuals responsible for the entire software development process. From theoretical design to programming, these graduates will provide project leadership and technical guidance along every stage of the software development life cycle.

DSU and SDSU have success in the shared Masters in Data Science/Analytics major since 2014 and plan to use that model when preparing this collaborative program.

2. What is the need for the proposed program (e.g., Regental system need, institutional need, workforce need, etc.)? What is the expected demand for graduates nationally and in South Dakota (provide data and examples; data sources may include but are not limited to the South Dakota Department of Labor, the US Bureau of Labor Statistics, Regental system dashboards, etc.)?

The workforce need for software engineers is discussed in detail below, but the workforce need is very high. Finally, given the mission and capacity of the Beacom College of Computer and Cyber Sciences at DSU and the Jerome J. Lohr College of Engineering at SDSU, make this an ideal collaboration. DSU and SDSU have nearly 550 computer science majors with 350 at DSU and 200 at SDSU. The combined strength of the two programs will provide a stable platform this highly valued field of study.

Both institutions offer top drawer instruction and experiences in computer science, with DSU offering the undergraduate certificate through the Ph.D. while SDSU offers the B.S. and M.S. in Computer Science. Adding software engineering is consistent with the universities' missions, consistent with their capacity, and responsive to the need to provide more software professionals.

The U.S. Bureau of Labor Statistics (BLS) projects that jobs for software developers will grow by 17% from 2014 to 2024, making software engineering one of the faster growing sectors in the job market.

From the Occupational Outlook Handbook, there is evidence of a growing need for software development professionals.⁴ The demand for skilled and qualified software engineers is bolstered by a transforming economic landscape, driven by the need for computing technology

³https://study.com/articles/Software_Engineers_Job_Duties_and_Requirements_for_Becoming_a_Software_Engineer.html

⁴<https://www.bls.gov/ooh/computer-and-information-technology/software-developers.htm>

solutions. With the advent of the Internet, smart cities, green technology and big data, all industries and organizations are quickly becoming technology industries.

Quick Facts: Software Developers	
2017 Median Pay ?	\$103,560 per year \$49.79 per hour
Typical Entry-Level Education ?	Bachelor's degree
Work Experience in a Related Occupation ?	None
On-the-job Training ?	None
Number of Jobs, 2016 ?	1,256,200
Job Outlook, 2016-26 ?	24% (Much faster than average)
Employment Change, 2016-26 ?	302,500

With such unprecedented growth in a multitude of industries and organizations, software engineers can pursue careers in any number of industries, including technology, healthcare, automotive manufacturing, green energy, remote sensing, precision agriculture, aeromautics and finance. New jobs such as automotive embedded software engineer, health informatics engineer and financial software engineer are emerging as each of these sectors continue to expand. The M.S. degree is needed so as to provide leadership in the development and work of teams including research and development.

A master's degree will lead to increased job opportunities. Currently Glassdoor.com lists 21,137 job openings for positions that require either work experience or a masters degree. Typical requirements read "Bachelor's and 5 or more years' experience, Master's degree with 3 or more years' experience or PhD degree with experience. Bachelor, Master or Doctorate of Science degree from an accredited course of study, in engineering, computer science, mathematics, physics or chemistry. ABET is the preferred, although not required, accreditation standard." This is from a listing from BOEING with Software Engineer as the title.⁵ Cisco Systems lists an entry level position that requires an M.S. degree for consideration.

In addition to national demand, strong growth is expected for positions as software engineers within South Dakota. For example, the SD Department of Labor and Regulation notes that employment of software developers is expected to grow between 14-24% in Rapid City and Sioux Falls with a total of about 24 annual job openings in those two cities through 2024.⁶

3. How would the proposed program benefit students?

The administration and faculty at both DSU and SDSU recognize the rapid pace of advancement in fields like software engineering. Using previous models of shared programs, students at both universities will complete core courses at both institutions and then specialize in specific niches at their home institution. This model has operated successfully making both institutions stronger, benefitting graduates and the regional workforce development, and efficiently utilizing precious faculty resources at both institutions.

⁵ https://www.glassdoor.com/Job/master-software-engineer-jobs-SRCH_KO0,24.htm

⁶ Labor Market Information Center, South Dakota Department of Labor and Regulation, July 2017. Available from https://dlr.sd.gov/lmic/documents/substate_occupational_projections_2014_2024.xlsx

These benefits for students in adding the proposed degree pattern include (a) development of excellent analytical skills because they will be required to continually compare needs with software capabilities; (b) familiarity with computer languages in order to effectively work with computer programs, i.e., professional flexibility; (c) the development of formidable feedback and communication skills, avoiding error or miscommunications; (d) capacity to monitor project updates and reported defects in order to manage necessary modifications, i.e., a capacity to shift gears between assigned projects, deadlines and schedules; (e) software engineers must conduct experimental software runs to ensure quality and consistency; (f) in many ways, these graduates must develop an eye for perfection in order to properly direct repairs and revisions of programs; and some software developers will become the primary point of contact with clients and vendors. These are substantial and formidable advantages to students.

South Dakota currently does not produce software engineering graduates of this nature or at this level. This kind of degree will assist government leaders, corporation executives, states and localities in developing good applications and focus on user accessibility and convenience. Graduates are necessary to fill jobs at the federal, state, local and corporate levels. On the federal, state and local levels these students will be the beneficiaries of good, relatively high paying career-predictive jobs.

4. How does the proposed program relate to the university's mission as provided in South Dakota Statute and Board of Regents Policy, and to the current Board of Regents Strategic Plan 2014-2020?⁷

The Legislature established Dakota State University as an institution specializing in programs in computer management, computer information systems, and other related undergraduate and graduate programs as outlined in SDCL 13-59-2.2. The Beacom College of Computer and Cyber Sciences provides complete realization of this mission in its programs related to computer science, network administration, computer game design and cybersecurity. The Board implemented SDCL 13-59-2.2 by authorizing undergraduate and graduate programs that are technology-infused and promote excellence in teaching and learning. These programs support research, scholarly and creative activities and provide service to the State of South Dakota and the region.

The legislature established South Dakota State University as the Comprehensive Land Grant University to meet the needs of the State and region by providing undergraduate and graduate programs of instruction in the liberal arts and sciences and professional education in agriculture, education, engineering, human sciences, nursing, pharmacy, and other courses or programs as the Board of Regents may determine (SDCL 13-58-1). SDSU's Jerome J. Lohr College of Engineering supports a variety of engineering programs as well as undergraduate and graduate computer science programs.

In addition, the SDBOR Strategic Plan 2014-2020 includes the following vision:

- South Dakotans will have increased access to continuing education opportunities needed to upgrade their credentials while remaining in the workforce;

⁷ South Dakota statutes regarding university mission are located in SDCL 13-57 through 13-60; Board of Regents policies regarding university mission are located in Board Policies 1:10:1 through 1:10:6. The Strategic Plan 2014-2020 is available from https://www.sdbor.edu/the-board/agendaitems/Documents/2014/October/16_BOR1014.pdf.

- South Dakota will have a working-age population with advanced levels of education needed to support our democracy and the modern, knowledge-based economy; and
- South Dakota will be a recognized national leader in the use of information technology to enhance its educational, economic, social, scientific, and political development.
- Increase the number of master’s and doctoral level STEM programs.

Adding a collaborative software engineering M.S. degree at DSU and SDSU is consistent with the board-designated missions of the universities, supports system goals, and will contribute to the state’s workforce and economic development as this program aligns nicely with existing and future state workforce needs.

5. Do any related programs exist at other public universities in South Dakota? If a related program already exists, explain the key differences between the existing programs and the proposed program, as well as the perceived need for adding the proposed new program. Would approval of the proposed new program create opportunities to collaborate with other South Dakota public universities?⁸ If there are no related programs within the Regental system, enter “None.”

The University of South Dakota offers the M.S. (including an accelerated option) in Computer Science with an Informatics specialization. The South Dakota School of Mines and Technology offers the M.S. degree in Computational Science and Robotics (focus on software robotics).

The key differences between these programs and the proposed collaborative program in Software Engineering is that Software Engineering is focused on methodologies, techniques, and the tools used to manage the entire software life cycle. A typical Computer Science degree will focus on principles and use of computers that covers both theory and application.

6. Do related programs exist at public colleges and universities in Minnesota, North Dakota, Montana, and/or Wyoming? If a related program exists, enter the name of the institution and the title of the program; if no related program exists, enter “None” for that state. Add additional lines if there are more than two such programs in a state listed.⁹

	Institution	Program Title
<i>Minnesota</i>	University of Minnesota - Twin Cities	Software Engineering (M.S.)
<i>North Dakota</i>	North Dakota State University	Software Engineering (M.S.)
<i>Montana</i>	None at Master’s level	
<i>Wyoming</i>	None at graduate level	
<i>Iowa</i>	None at graduate level	

⁸ Lists of existing system programs are available through university websites and the RIS Reporting: Academic Reports database available from <http://apps.sdbor.edu/ris-reporting/AcademicProgramReports.htm>.

⁹ This question addresses opportunities available through Minnesota Reciprocity and WICHE programs such as the Western Undergraduate Exchange and Western Regional Graduate Program in adjacent states. List only programs at the same degree level as the proposed program. For example, if the proposed program is a baccalaureate major, then list only related baccalaureate majors in the other states and do not include associate or graduate programs.

Large online universities like Arizona State are reaching into South Dakota and offering more similar degrees than those listed above. Most online master's in software engineering programs are designed for people with an undergraduate degree in computer science, engineering, information technology, or a related field. Some will admit students without a computer degree if they have a programming background.

7. Are students enrolling in this program expected to be new to the university or redirected from other existing programs at the university?

The majority of students enrolling in this program are expected to be new to the universities, though some current students in related areas may decide to pursue this more specific major in software engineering. Due to the availability of associate and bachelor's level programs in software development and engineering in the SDBOR system, students will be well-prepared to enter the graduate program and to return to increase their level of education into the future.

8. What are the university's expectations/estimates for enrollment in the program through the first five years? What are the university's expectations/estimates for the annual number of graduates from the program after the first five years? Provide an explanation of the methodology the university used in developing these estimates.

Year 1 – 5: 50 -60 students in the combined program after year 5

9. Complete the following charts to indicate if the university intends to seek authorization to deliver the entire program at any off-campus location (e.g., UC Sioux Falls, Capital University Center, Black Hills State University-Rapid City, etc.) or intends to seek authorization to deliver the entire program through distance technology (e.g., as an on-line program)?¹⁰

	Yes/No	Intended Start Date
On campus	Yes	Fall 2019

	Yes/No	If Yes, list location(s)	Intended Start Date
Off-campus	No		

	Yes/No	If Yes, identify delivery methods	Intended Start Date
Distance Delivery	Yes	Online delivery	Fall 2019

10. What are the university's plans for obtaining the resources needed to implement the program? Indicate "yes" or "no" in the columns below.

	Development/ Start-up	Long-term Operation
Reallocate existing resources	Yes	Yes

¹⁰ The accreditation requirements of the Higher Learning Commission (HLC) require Board approval for a university to offer programs off-campus and through distance delivery.

	Development/ Start-up	Long-term Operation
Apply for external resources	Yes	Yes
Ask Board to seek new State resources ¹¹	No	No
Ask Board to approve a new or increased student fee	No	No

DSU has hired several faculty as part of the Sanford/Beacom gift and some of those faculty have the requisite expertise in software engineering to augment the expertise of existing faculty at DSU and SDSU. SDSU plans to fill a currently open position with a software engineer in order to augment existing software engineering personnel.

11. Curriculum Example: Provide (as Appendix A) the curriculum of a similar program at another college or university. The Appendix should include required and elective courses in the program. Catalog pages or web materials are acceptable for inclusion. Identify the college or university and explain why the selected program is a model for the program under development.

The attached curriculum in Appendix A is for the Master of Science and Master of Software Engineering from North Dakota State University. The information may be found online at <https://bulletin.ndsu.edu/programs-study/graduate/software-engineering/#degreerequirementstext>.

The Master of Science in Software Engineering will serve students who have earned a bachelor's degree in software engineering, computer science or a related discipline, as well as working software engineers who want to broaden their perspective while deepening their skills in software development and software engineering. The program plans to accept students who are already competent programmers wanting to prepare for careers in software engineering. Courses in this program are taught at a level that assumes that all students have a technical undergraduate degree and significant programming experience.

DSU and SDSU anticipate the master's program in software engineering will require a minimum of 30 credit hours of approved graduate study. Students will be encouraged to complete and successfully defend a thesis. Students who decide against writing a thesis must pass a final program examination. The curriculum will include required material: Software Engineering, Software Testing and Software Metrics and Modeling. All students are required to pass the Computer Science Seminar or the Computer Sciences Internship twice during the degree program. The internship is completed with an information technology business or industrial organization and is available only for students without prior experience in a practical information technology setting.

DSU will augment their capacity to offer the appropriate coursework by securing external funding for operation and support, the use of the DSU Rising! This will include additional software engineering faculty.

¹¹ Note that requesting the Board to seek new State resources may require additional planning and is dependent upon the Board taking action to make the funding request part of their budget priorities. Universities intending to ask the Board for new State resources for a program should contact the Board office prior to submitting the intent to plan.

APPENDIX A

Example M.S. in Software Engineering - North Dakota State University

Software Engineering

Masters of Software Engineering

Code	Course List Title	Credits
Core Courses - 15 Credits		
CSCI 713	Software Development Processes	
CSCI 715	Software Requirements Definition and Analysis	
CSCI 716	Software Design	
CSCI 718	Software Testing and Debugging	
CSCI 848	Empirical Methods in Software Engineering	
Electives - 15 Credits		
CSCI 714	Software Project Planning and Estimation	
CSCI 717	Software Construction	
CSCI 724	Survey of Artificial Intelligence	
CSCI 736	Advanced Intelligent Systems	
CSCI 765	Introduction To Database Systems	
CSCI 834	Knowledge Based Systems	
CSCI 846	Development of Distributed Systems	
CSCI 847	Software Complexity Metrics	
Total Credits - 30		

Master of Science

Code	Course List Title	Credits
Core Courses		12
Students must complete the core within five semesters of their entering the program.		
CSCI 713	Software Development Processes	
CSCI 715	Software Requirements Definition and Analysis	
or CSCI 718	Software Testing and Debugging	
CSCI 716	Software Design	
CSCI 765	Introduction To Database Systems	
Six credits (not part of the core) from:		6
CSCI 714	Software Project Planning and Estimation	
CSCI 715	Software Requirements Definition and Analysis	
CSCI 717	Software Construction	
CSCI 718	Software Testing and Debugging	
CSCI 845	Formal Methods for Software Development	
CSCI 846	Development of Distributed Systems	

Code	Course List Title	Credits
CSCI 847	Software Complexity Metrics	
CSCI 848	Empirical Methods in Software Engineering	
	Other Computer Science or Computer Engineering courses selected with and approved by the student's graduate advisory committee. (six -thesis students) or three (paper students)	3-6
CSCI 790	Graduate Seminar (in software engineering areas (1 credit each), approved by adviser)	3
	Research Component*	3-6
CSCI 797 or CSCI 798	Master's Paper Master's Thesis	
	Total Credits	33