

SOUTH DAKOTA BOARD OF REGENTS

Academic and Student Affairs

AGENDA ITEM: 6 – D (1)

DATE: April 2-4, 2019

SUBJECT

Intent to Plan: SDSU and DSU – BS and MS in Software Engineering

CONTROLLING STATUTE, RULE, OR POLICY

[BOR Policy 2:23](#) – Program and Curriculum Approval

BACKGROUND / DISCUSSION

South Dakota State University (SDSU) and Dakota State University (DSU) request authorization to prepare a proposal for a collaborative Bachelor of Science (BS) and Master of Science (MS) in Software Engineering. The programs would go beyond existing programs in Computer Science in providing education in the development and application of techniques leading to the creation of reliable software. The programs will benefit from the expertise in engineering at SDSU and DSU’s expertise in software development and technology related programs. SDSU and DSU currently have a collaborative master’s program in Data Science/Analytic. Graduates from the program would enter a rapidly developing field with high demand in private and public sectors. The proposal cites US Bureau of Labor Statistics data indicating 24% growth nationally through 2026.

IMPACT AND RECOMMENDATION

The proposed programs are within the mission of SDSU as presented in [SDCL 13-58-1](#) and [BOR Policy 1:10:2](#), and the mission of DSU as presented in [SDCL 13-59-2.2](#) and [BOR Policy 1:10:5](#). Related programs in Computer Science exist at SDSU, DSU, USD, and SDSM&T at the bachelor’s level and at SDSU, DSU, and USD at the master’s level; however, the Software Engineering programs will have greater focus on software development, testing, and modeling.

Neither institution anticipates asking for new state resources for the programs.

(Continued)

DRAFT MOTION 20190402_6-D(1):

I move to authorize SDSU and DSU to develop a program proposal for a BS and MS in Software Engineering, as presented.

Board office staff recommends approval of the intents to plan with the following conditions:

1. The university will research existing curricula, consult with experts concerning the curriculum, and provide assurance in the proposal that the program is consistent with current national standards and with the needs of employers.
2. The proposal will define the specific knowledge, skills, and competencies to be acquired through the program, will outline how each will be obtained in the curriculum and will identify the specific measures to be used to determine whether individual students have attained the expected knowledge, skills, and competencies.
3. The university will not request new state resources without Board permission, and the program proposal will identify the sources and amounts of all funds needed to operate the program and the impact of reallocations on existing programs.

ATTACHMENTS

Attachment I – Intent to Plan Form: SDSU & DSU – BS in Software Engineering

Attachment II – Intent to Plan Form: SDSU & DSU – MS in Software Engineering



**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:	B.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.

J. M. Gustaf

President of the University, Dakota State University

8/20/2018

Date

Bruce H. Dunn

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 program is to provide skilled and knowledgeable graduates who will meet the needs of businesses and organizations in writing, editing and testing software. 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.

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.

Educational requirements for software engineers include 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

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

² IEEE Standard Glossary of Software Engineering terminology

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 Bachelor of Science (B.S.) level. Responding to the national need for professionals in computer science, cyber security, computer network development and web development for public and private organizations, the proposed major 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.

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 very robust. Currently, DSU and SDSU have nearly 550 computer science majors combined with approximately 350 majors at DSU and 200 at SDSU.

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

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

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 2024.⁵

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

⁵ 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

Statewide during the 2016 period there were 42 openings and it is expected that close to 800 openings will need to be filled during the 2016-2026 time period⁶.

Federal and state governments, large and medium size corporations, the military, including the National Guard and Reserve, all need graduates educated with this type of skill set and knowledge base.

3. How would the proposed program benefit students?

The proposed bachelor's degree in software engineering will be of benefit to students by preparing them to be highly competitive in a field where those equipped with knowledge and skills in software engineering are very employable in relatively high paying positions. The program will offer educational experiences that assist students in becoming program solvers for society with the tools, knowledge and vision to build systems and applications and the ability to manage the development, maintenance and evolution of software.

Because this is a collaborative proposed program, students will benefit from the resources offered by both institution and will complete shared core courses and then specialize in specific niches at their home institution. This model has operated successfully making both institutions stronger, benefitting graduate and regional workforce development and effectively utilizing faculty resources.

DSU is developing a stackable progression in this area. Starting with the current A.S. in software development at DSU or other schools, a student will be able to stack those credits into the B.S. in Software Engineering degree or at least the specialization. This provides the student the opportunity to scaffold of their software engineering skill set while the college can use the courses most efficiently.

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

⁶ South Dakota Dept. of Labor, Dec. 2018, Available from <https://www.southdakotaworks.org/vosnet/analyzer/results.aspx?session=occpj>

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.

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;
- 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.

Adding a collaborative software engineering B.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 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 (USD) and the South Dakota School of Mines and Technology (SDSM&T) currently both offer the bachelors' level program in Computer Science. Dakota State offers the Software Development (A.S.) and a specialization in software and web development within its Computer Information Systems major, and South Dakota State offers a minor in software engineering and the B.S. in Computer Science.

The bachelor's level degree in software engineering provides students with the needed content and skill development in order to design, build, and maintain software systems throughout the life of the system. This differs from computer science, as it is the theory and practice of processing and using information. The software engineer works to satisfy the customer requirements for the overall project, while the computer scientist is concerned with developing the specific algorithms for solving individual problems. A software engineer will work with the team and the customers while the computer scientist will work with coding the solution.

- 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

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.

	Institution	Program Title
<i>Minnesota</i>	University of Minnesota	Software Engineering (B.S.)
<i>North Dakota</i>	North Dakota State University	Computer Engineering (B.S.)
<i>Montana</i>	Montana Tech of the University of Montana	Software Engineering (B.S.)
<i>Iowa</i>	Iowa State University	Software Engineering (B.S.)

SDSU formerly offered a B.S. in Software Engineering from 2003 through 2011. The B.S. in Software Engineering was terminated due to its status as a relatively new program when the Regental system endured statewide budget cuts. SDSU noted at the time a desire to eventually reauthorize the program.

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 in the program are expected to be new to DSU and SDSU. When the program was created at SDSU, several Computer Science majors switched to Software Engineering as they were interested in the new opportunity. However, once the program was established SDSU was able to attract students due to the program and we anticipate this will be true when the program is restarted. There may also be interest from students who are currently in data science wishing to change their major to software engineering. The stackability of programs offered will also encourage students to continue in the software engineering major as they move from the associates to bachelors to master’s levels.

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.

DSU and SDSU anticipate that in the first year of the program, five students will be enrolled at both institutions. Over time, an average of 15 or more students are expected to be enrolled each year.

Typically DSU strives for about a 1:1 mix by modality. DSU’s A.S. in Software Development is in it’s second year and already has 12 enrolled students (Fall 2018) who are potential students for the B.S. degree. An affordable software engineering degree should be in high demand.

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

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.

		Yes/No	Intended Start Date
On campus	DSU	Yes	Fall 2019
	SDSU	Yes	Fall 2019

	Yes/No	If Yes, list location(s)	Intended Start Date
Off-campus	No		Fall 2019

		Yes/No	If Yes, identify delivery methods	Intended Start Date
Distance Delivery	DSU	Yes	Online	Fall 2019
	SDSU	Yes	Online	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. Need to provide brief explanation and examples of likely external resources (if Yes is indicated)

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

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 curriculum example included in Appendix A is from Iowa State University. The information may be found online at <http://catalog.iastate.edu/collegeofengineering/softwareengineering/>.

The specific design of the undergraduate curriculum has been heavily debated and still is. Institutions will often offer slightly differing course structures, many may have a stronger focus on mathematical foundations for example. It is true, however, that students of a four-year software engineering course will typically have a similar first year of study as students of Computer Science, including classes such as computer programming, program design, computer systems analysis, fundamentals of hardware, networking and computer architecture. In addition to these computer science courses, software engineering programs typically offer course work like introduction to software engineering, software requirements & modeling,

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.

software design & construction, software testing, verification, and validation, software quality assurance, software project management, and software configuration management.

DSU and SDSU plan to pursue a similar model to the M.S. in Data Science/Analytics cooperative programs. Both DSU and SDSU recognize that they have a successful, collaborative process and team that allows them to develop premier programs in specialized areas related to computing and data. They look forward to continuing and strengthening their joint commitments in these important specialties for South Dakota.

DSU and SDSU will be adding 4-5 new courses, most of which can be covered by existing faculty offering the programs. An emphasis often serves a fundamentally different purpose than a major. A specialization within a computer science program may provide some software engineering skills/tools which may be all that is needed or appropriate for some positions, however, it may not serve as well when a stand alone degree or specific credentials are required. It will also include some ancillary changes, for example, additional math courses may be added to the curriculum.

DSU will augment their capacity to offer the appropriate coursework by securing external funding for operation and support, the use of the DSU Rising! gift, the strategic use of adjuncts, and potentially, the use of remote faculty to provide richness and depth to the curriculum. This will include additional software engineering faculty. They currently have several faculty with expertise in this area that teach several courses to support an A.S. in Software Development and several graduate level courses software engineering.

APPENDIX A

Example B.S. in Software Engineering - Iowa State University

The Software Engineering program is an interdisciplinary program delivered jointly by the College of Engineering and the College of Liberal Arts & Sciences.

Leading to the degree bachelor of science.

Total credits required: 125 cr. Any transfer credit courses applied to the degree program require a grade of C or better (but will not be calculated into the ISU cumulative GPA, Basic Program GPA or Core GPA). See also Basic Program and Special Programs. Note: Pass/Not Pass credits cannot be used to meet graduation requirements.

International Perspectives: 3 cr.¹

U.S. Diversity: 3 cr.¹

Communication Proficiency/Library requirement:

ENGL 150 Critical Thinking and Communication (Must have a C or better in this course)	3
ENGL 250 Written, Oral, Visual, and Electronic Composition (Must have a C or better in this course)	3
LIB 160 Information Literacy	1
Choose one of the following:	3
ENGL 309 Proposal and Report Writing (C or better in this course)	
ENGL 314 Technical Communication (C or better in this course)	
Total Credits	10

General Education Electives: 15 cr.²

Choose 1 course from the following:	3
ECON 101 Principles of Microeconomics	
ECON 102 Principles of Macroeconomics	
I E 305 Engineering Economic Analysis	
Arts and Humanities	6
Social Sciences	3
Additional Arts and Humanities or Social Sciences course	3
Total Credits	15

Basic Program: 27 cr.

A minimum GPA of 2.00 is required for this set of courses, including any transfer courses (please note that transfer course grades will not be calculated into the Basic Program GPA). See Requirement for Entry into Professional Program in College of Engineering Overview section.

CHEM 167 General Chemistry for Engineering Students	4
or CHEM 177 General Chemistry I	
ENGL 150 Critical Thinking and Communication (Must have a C or better in this course)	3

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ENGL 250	Written, Oral, Visual, and Electronic Composition (Must have a C or better in this course)	3
S E 101	Software Engineering Orientation ³	R
S E 185	Problem Solving in Software Engineering ³	3
LIB 160	Information Literacy	1
MATH 165	Calculus I	4
MATH 166	Calculus II	4
PHYS 221	Introduction to Classical Physics I	5
Total Credits		27

Math and Physical Science: 11 cr.

COM S 227	Introduction to Object-oriented Programming	4
COM S 228	Introduction to Data Structures	3
MATH 267	Elementary Differential Equations and Laplace Transforms	4
Total Credits		11

Software Engineering Core: 37 cr.

A minimum GPA of 2.00 is required for this set of courses, including any transfer courses (please note that transfer course grades will not be calculated into the Core GPA):

CPR E 281	Digital Logic	4
	Choose one of the following:	3
COM S 327	Advanced Programming Techniques	
CPR E 288	Embedded Systems I: Introduction	
	Choose one of the following:	3
COM S 321	Introduction to Computer Architecture and Machine-Level Programming	
CPR E 381	Computer Organization and Assembly Level Programming	
	Choose one of the following:	3
COM S 352	Introduction to Operating Systems	
CPR E 308	Operating Systems: Principles and Practice	
	Choose one of the following:	3
COM S 230	Discrete Computational Structures	
CPR E 310	Theoretical Foundations of Computer Engineering	
COM S 311	Design and Analysis of Algorithms	3
COM S 363	Introduction to Database Management Systems	3
COM S 309	Software Development Practices	3
S E 319	Software Construction and User Interfaces	3
S E 329	Software Project Management	3
S E 339	Software Architecture and Design	3
S E 421	Software Analysis and Verification for Safety and Security	3

Note: CPR E 288, CPR E 381 and CPR E 308 are 4-credit courses. The core credit requirement (37 credits) is given in terms of 3-credit courses. If the 4-credit courses are taken instead, then the extra credits will be used as credits for Supplementary Electives.

Total Credits 37

Other Remaining Courses: 35 cr.

S E 491	Senior Design Project I and Professionalism	3
S E 492	Senior Design Project II	2
SP CM 212	Fundamentals of Public Speaking	3
STAT 330	Probability and Statistics for Computer Science	3
One of the following ENGL courses (with a C or better in this course)		3
ENGL 309	Proposal and Report Writing	
ENGL 314	Technical Communication	
Math Elective: Choose one from the following list		3
MATH 207	Matrices and Linear Algebra	
MATH 265	Calculus III	
MATH 304	Combinatorics	
MATH 314	Graph Theory	
MATH 317	Theory of Linear Algebra	
Software Engineering Elective ²		6
Supplementary Elective ²		9
Open Elective ²		3
Total Credits		35

Seminar/Co-op/Internships

S E 166	Careers in Software Engineering	R
S E 494	Software Engineering Portfolio Development	R
Co-op or internship (S E 396, S E 397, S E 398) is optional		

Transfer Credit Requirements

The degree program must include a minimum of 30 credits at the 300-level or above in professional and technical courses earned at ISU in order to receive a B.S. in software engineering. These 30 credits must include S E 491 Senior Design Project I and Professionalism and S E 492 Senior Design Project II and credits in the core professional curriculum and/or in technical electives. The software engineering degree program requires a grade of C or better for any transfer credit course that is applied to the degree program.

1. These university requirements will add to the minimum credits of the program unless the university-approved courses are also approved by the department to meet other course requirements within the degree program. U.S Diversity and International Perspectives courses may not be taken Pass/Not Pass.
2. Choose from department approved lists.
3. See Basic Program for Professional Engineering Curricula for accepted substitutions for curriculum designated courses in the Basic Program.

See also: A 4-year plan of study grid showing course template by semester.

Note: International perspectives and U.S. diversity courses are used to meet the general education electives.



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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.

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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.

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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.

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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. Currentyly 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	

Course List		
Code	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	Master's Paper	
or CSCI 798	Master's Thesis	
Total Credits		33