

PROGRAM REVIEW

Dakota State University

**Doctor of Philosophy (PhD) in Cyber Operations
The Beacom College of Computer and Cyber Sciences**

Review Conducted May 9, 2023

Reviewers

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PART 1: Executive Summary

The review of the Ph.D. in Cyber Operations was conducted on site at Dakota State University (DSU) by two experienced cybersecurity faculty from The University of Alabama in Huntsville on May 9, 2023. Both reviewers had visited DSU in the past so both were somewhat familiar with the campus, the cybersecurity faculty, and the facilities. Overall, the Ph.D. in Cyber Operations program is healthy and has an outstanding national reputation for teaching cybersecurity skills to its students and is recognized by national level credentials. The faculty are exceptionally dedicated to this program and well qualified to deliver the technical material required. It is clear to the reviewers that substantial effort has taken place at DSU to increase the number, quality, and academic diversity of the cybersecurity faculty. The facilities dedicated to this and other cybersecurity programs are outstanding and they continue to grow and improve. It was noted that DSU produces a unique PhD graduate that is “industry ready” and well versed in applied cybersecurity research.

The original Doctor of Science in Cyber Security created in 2014 was one of the very first in the country. Its rapid growth was testimony to its need and program quality. The subsequent renaming of the degree to Doctor of Philosophy in Cyber Operations and creation of a Ph.D. in Cyber Defense in 2018 appears to have been an excellent decision which allowed for students not having an adequate technical background to still pursue their studies at an advanced level and allowed the faculty to focus more attention on highly technical subjects within the Cyber Operations program. Both PhD programs seem to have leveled out in terms of student enrollment and success.

The Ph.D. curriculum requiring 61 credit hours, a comprehensive exam, a proposal defense, and a dissertation defense conforms with national standards for similar programs and the reviewers had no concerns with the core courses, the electives, or the overall Ph.D. requirements. It appears to be a rigorous curriculum accomplished by highly qualified and dedicated faculty. Students interviewed understood the requirements for the program and were largely satisfied with it as well as with the structured nature of the program which allowed for those not on campus to make long range plans for their program of study. It was recommended that the Dissertation Preparation course (CSC 809) be offered earlier in the program of study.

The faculty teaching and advising loads seem very high. While some relief is granted for research active faculty – the loads still seem higher than that normally found at other PhD granting institutions we are familiar with. Additionally – it was recommended that more emphasis be placed on requiring PhD student publications – an area that appears lacking now. The increase in research funding is commendable and the creation of a VP for Research and Economic Development in 2018 seems to have had the intended effect and has focused faculty

efforts on research activity. Additionally, the external support created through the DSU Rising initiatives is exemplary and demonstrates the importance placed by others on the DSU programs.

PART 2: Institutional Program Review Itinerary

Tuesday, May 9, 2023

Reviewers: Dr. Tommy Morris, The University of Alabama, Huntsville
Dr. Rayford Vaughn, The University of Alabama, Huntsville

- 9:00 am Dr. Mark Hawkes, Dean of Graduate Studies
Review Agenda, Functions of Graduate Office
- 10:00 am Dr. Pat Engebretson, Dean, Beacom College of Computer and Cyber Sciences
Dr. Yong Wang, Graduate Program Coordinator, Ph.D.CO
- 11:00 am Dr. Morris meet with Ph.D. CO program faculty
Dr. Vaughn meet with other Beacom College computing faculty
- 12:00 noon Lunch w/Dr. Rebecca Hoey, Provost; Dr. Mark Hawkes; and Dr. Yong Wang
- 1:00 pm Dr. Morris meet with current Ph.D.CO students (interactive video)
Dr. Vaughn meet with Ph.D.CO alumni (interactive video)
- 2:00 pm Break
- 2:30 pm Support Staff:
Abby Chowning, Graduate Enrollment Counselor
Brianna Feldhaus, Graduate Enrollment Counselor
Sarah Rasmussen, Director of Online Education
Dr. Jeanette McGreevy, Director of Institutional Effectiveness,
Assessment and Policy
Kathy Callies, Registrar
- 3:30 pm Tour of Madlabs and interview
Dr. Ashely Podhradsky, VP Research and Economic Development
Dr. Peter Hoelsing, Associate VP Research and Economic Development
- 4:30 pm External Review Debrief w/Dr. Hoey, Dr. Hawkes and Dr. Wang

Part 3: Program Evaluation

1. Program goals and strategic planning: The South Dakota Board of Regents policy states “Students who attend Dakota State University pursue highly technical degrees with a broad focus in current and emerging computing and information technologies/cyber security that emphasize innovation, leadership, application, and research. DSU has the authority to credential certificates, associate degrees, baccalaureate degrees, master’s degrees and doctoral degrees provided formal approval by the Board of Regents.” Clearly this mission is being met and exceeded in the opinion of the reviewers. The Ph.D. in Cyber Operations seems to be the flagship program at the university with respect to technical content and National reputation. The current Strategic Plan DSU ADVANCE 2027, is in place with reasonable objectives. The administrators and faculty that we interviewed were well aware of the strategic plan and highly complimentary of the administration’s efforts to move DSU forward following this plan.

1a. Appropriateness of goals and whether / not goals are being met: The goals most certainly appear appropriate to the reviewers and, more importantly, they seem to be reasonable and achievable. The foundational goals and our observation on each are as follows:

- *Ensure Financial Stability:* The reviewers had no visibility into this goal, but given the increase in faculty, facilities, and enrollment it would seem that this goal is most certainly being met. Additionally, the success of the “DSU Rising” initiatives demonstrates the strong external support for the university as well as bringing in very large financial contributions that support DSU’s many programs.
- *Strengthen Regional and National Relevance:* With respect to the PhD program in Cyber Operations, this goal is definitely being met and even exceeded. DSU has an excellent National reputation and is strongly supported by the U.S. Department of Defense (DoD). Within the cybersecurity academic community DSU is well known for its excellent technical programs.
- *Enhance Ability to Recruit and Retain Talent:* This goal is clearly being met – while all cybersecurity programs have difficulty attracting and retaining talent, the DSU cyber faculty are growing in number and diversity of institutions from which they graduated. It was noted that this has greatly improved over the past 10 years and current faculty are fully aware that the institution administration is working to continue recruiting and growing the program.
- *Increase Student Enrollment:* Since the program was originally created/approved in 2014 the enrollment steadily increased in terms of applicants and enrolled students up until 2018. The administration realized that not all students being admitted had the necessary technical background to succeed in some of the more technical classes such as reverse engineering and software exploitation. A new doctoral program in Cyber Defense was established in 2018 which was more suited to the less technical but otherwise qualified student. This resulted in a leveling off of applications and enrollments in the Cyber Operations PhD program to a steady state of approximately 55 enrollments/year.

- *Enhance Student Success:* It was the reviewers' opinion that the faculty, administration and support staff were highly attuned to supporting the students and helping them achieve success. The students we interviewed (both current and past) were highly complimentary of the availability and helpfulness of DSU staff and faculty.
- *Maintain Higher Learning Commission Accreditation:* DSU has maintained continuous accreditation since 1961 and no issues were identified here.
- *Ensure Responsible Stewardship of State Resources:* DSU has enjoyed strong support from Federal and State elected officials. The facilities on campus are outstanding and very supportive of student engagement and faculty research. It appears that DSU has maximized its use of State and Federal funding.
- *Strengthen Risk Management Process:* This area was not reviewed with respect to the PhD in Cyber Operations program.

1b. Program goals relative to institutional mission: It is abundantly clear that DSU is fully executing the South Dakota Board of Regents assigned missions. The strategic plan foundational goals discussed in 1a. above demonstrate that the entire university is focused on its mission and objectives. The university is hiring highly capable and dedicated faculty and has established a strong support structure to ensure student success. Everyone we spoke with understood the mission of DSU.

1c. Program goals relative to current national trends and forecasts for the discipline: By virtue of DSU's designation as a Center of Academic Excellence (CAE) in Cyber Operations by the National Security Agency, we can be assured that the program meets current national trends since there is a very rigorous evaluation process conducted by the NSA and others along with a requirement that significant evidence be presented that current course work maps to specific knowledge and skills. There are very few universities that have achieved all the CAE credentials that DSU has acquired. Similarly, forecasts for this discipline include a continuous rise in the need for graduates as well as a need for rapidly changing curriculum to keep up with the frequent advances in cyber science and the threats that the Nation is faced with. DSU excels in this area.

2. Program resources: Program resources to support the PhD program in Cyber Operations would include an outstanding and diverse faculty, state-of-the-art classroom and laboratory facilities, and an excellent/dedicated support structure. All these necessary resources seem to be in place and institutionalized at DSU.

2a. Effective use of resources to meet program goals: Resources dedicated to the doctoral programs at DSU (including the Cyber Operations program) are state-of-the-art. While most doctoral students are not geographically located at DSU, the university provides an excellent computing infrastructure to facilitate research and learning and maintains a cyber range capable of isolating student experimentation and supporting PhD research in topics that would not be appropriate for a general purpose network. There is a classified facility on campus that can be

used to accommodate classified research and projects and an excellent facility (Madison Cyber Labs or MadLabs) from which projects can be managed and research can be conducted in advanced technology application. Impressive facilities such as the MadLabs are also useful/helpful in attracting faculty and students to DSU.

2b. Faculty -- staffing levels and credentials: The Cyber Operations faculty and capability has been increasing for the past several years by administration intention and support. Faculty technical credentials are impressive and there is diversity in terms of institutions that the faculty graduated from. It was the opinion of the reviewers that the faculty workload is extremely high when compared to other PhD granting institutions and this negatively affects their ability to perform research activity in terms of publications, grants, and contracts. The typical full-time teaching load for tenured or tenure track faculty is 24 semester credit hours per academic year (fall and spring) when teaching only undergraduate courses and 18 hours per academic year when teaching undergraduate and graduate courses. This, when coupled with the faculty graduate advising duties leaves no time for significant research activity. DSU has a very hard-working faculty and they should be commended for their extraordinary dedication and effort – however the lack of time available for research and high teaching and advising workload is thought to be an impediment to attracting highly desirable faculty to DSU. The university has started some faculty research/travel support initiatives that are helpful. One such program is the Faculty Research Initiative (FRI) which is intended to encourage and facilitate faculty research and creative activity by competitively offering up to \$3,000 for individual faculty or up to \$5,000 for collaborative teams to work on a research project. DSU also routinely sets aside funding for instructional and professional travel and for faculty training where individual faculty can qualify for up to \$1,200 in financial support. While these are good initiatives, they are of limited value if the faculty lacks the time to focus on research.

2c. Classroom facilities: The reviewers did tour several classrooms within the Beacom College of Computer and Cyber Science. The classrooms were outstanding and very modern, however in a distance focused PhD program such as Cyber Operations, they are of limited use. DSU should however, be commended on their classroom facilities for those on-campus students that can take advantage of them.

2d. Laboratory facilities and equipment: As previously addressed, the laboratory facilities and equipment are outstanding. The Information Assurance Laboratory and the Madison Cyber Labs are excellent, modern, and well administered. They provide very good support for the geographically distanced doctoral students and are a great resource for those students on campus.

2e. Financial support: Financial aid opportunities for DSU students come from institutional and private sources. Financial aid policies and procedures for application, award, and distribution have been developed to support the graduate programs at DSU, but the reviewers note that few of the doctoral students enrolled in the Cyber Operations program are in need of this since most are full-time working professionals or under scholarship from a government grant program.

3. Program curriculum: The PhD program in Cyber Operations curriculum at DSU is consistent with similar curricula at other institutions that the reviewers are familiar with. DSU requires a total of 61 credits to meet the degree requirements. These 61 credits include 15 core course credits, 9 research course credits, 15 elective course credits, 3 residency credits, and 19 dissertation credits. Students are required to complete three on-site research seminars in a face-to-face setting at the Madison campus. These “residency” requirements are seen to be a real strength in the program in that they acquaint students with each other as well as contemporary cyber security research issues, allow students to report, present, and discuss articles pertinent to cyber security research and provide students an opportunity to meet faculty, identify a dissertation advisor, present their dissertation proposal defense, as well as complete the final dissertation defense and the required oral comprehensive exam. The curriculum itself is mapped to a large number of skills and knowledge requirements developed by the government and evaluated by the NSA. The reviewers identified no issues with the DSU doctoral Cyber Operations curriculum.

4. Technology integration: The reviews observed the integration of technology throughout the visit to DSU and it appears to be very well accomplished by the university. With respect specifically to the doctoral program in Cyber Operations, most of the students’ work is done outside the confines of the university and their interaction with DSU technology comes with the use of the information assurance laboratory and the virtual machines that they have access to from which to accomplish their class assignments and research activity. The library is fully supportive of student efforts and maintains subscriptions to several databases that the students have access to for research purposes. The Office of Online Education serves the needs of DSU students who are enrolled in the online and videoconferencing courses at the university. The office is an important provider of services to students. This office also serves the web needs of faculty, staff, and students at DSU and assists faculty in the design and implementation of courses delivered by various forms of technology. In summary – technology integration seems to be in the very DNA of DSU.

5. Program assessment: The assessment of the Ph.D. in Cyber Operations program is conducted through the Trojan Assessment Profile (TAP). The program learning outcomes (PLO) and the PLO assessment measures seem very reasonable to the reviewers and no major concerns were identified. The reviewers do recommend that an assessment measure addressing student publication activity be considered. PhD students are expected to publish their work in peer reviewed venues and that does not seem to be occurring in the current program.

5a. Appropriateness of assessment measures / activities for the discipline: No issues were identified with the appropriateness of the current assessment measures or the PLO’s themselves. As previously addressed – it is recommended that an assessment be created that addresses PhD student publications in peer reviewed venues. This is a standard expectation of PhD students and one that does not seem to be in place at DSU at the moment.

5b. Major-field assessment activities, relative to the program goals: This area was not reviewed.

5c. Program accreditation, if appropriate: The program is designated by the National Security Agency as a Center of Excellence in Cyber Operations – one of a very few nationally.

6. Student support/student enrollments: With respect to the doctoral program in Cyber Operations, student enrollment seems steady (since 2019) at around 55 students/year. DSU students in this program appear to be graduating from it at a rate of approximately 5 per year. The student support structure consisting of faculty, library and support services is outstanding (although the reviewers felt that the faculty were overloaded with teaching and advising responsibilities).

6a. Student recruitment efforts: Student recruitment into the doctoral program for Cyber Operations is currently being accomplished by a very good internet presence, reputation for having an outstanding program, and recommendations by outside agencies. These initiatives are satisfactory, and no changes are recommended. The program has such a good National reputation that heavy advertising is not necessary.

6b. Student enrollment numbers: Enrollment since 2019 has stabilized at between 50-55 students annually. This is very positive and given the size of the faculty it is recommended that the enrollment numbers remain at this level until additional faculty can be hired.

6c. Student graduation rates and student placement: While exact numbers were not provided, it appears that DSU is graduating about 5 PhD's a year in Cyber Operations. It was unclear how many students transfer to other programs at DSU or drop out completely – but overall, the program seems to be on par with others Nationally in graduation rates and student success. Placement doesn't seem to be an issue at all in this program since the majority of students are already employed working professionals. For those that might not be currently employed, placement comes rapidly since this is such a needed discipline and DSU's program is providing *industry ready* graduates.

6d. Student support services: The reviewers met with several staff members working in the area of student support services – Graduate Enrollment Counselors, Director of Online Education, Director of Institutional Effectiveness, Assessment, and Policy, and the Registrar. This is a group of extremely dedicated staff doing an excellent job. We received many positive comments from students in the program (past and present) as well as from the faculty. There are no recommendations for change in this area. Student support services are outstanding in their work and effectiveness.

6e. Academic advising: Academic advising is accomplished by a two-tiered approach. Once accepted into the program, graduate enrollment counselors reach out to new students to coordinate student on-boarding activities including admissions, orientation, and academic advising (being accomplished very effectively at the present). The graduate enrollment counselors provide a great deal of important and needed support to new students and become their personal point of contact at the university for any issue the student is dealing with. New

doctoral students are also assigned a graduate faculty advisor - Program Coordinator Dr. Yong Wang serves as an academic advisor for each student upon entry to the Ph.D. in the Cyber operations program until a dissertation advisor is selected. The dissertation advisor then helps the student with their research and dissertation efforts. A doctoral dissertation committee is formed when a student is ready to conduct proposal defense and dissertation defense consisting of three individuals from the cyber operations faculty. The students in the program (past and present) had no concerns with advising and were complimentary toward the overall process.

7. Program strengths and areas for improvement: The PhD program in Cyber Operations at DSU has a very strong National reputation that has been gained from many years of providing excellent and highly technical graduates that are prepared to work right away in industry and government positions. The faculty (both Cyber Operations and Beacom College) are very collaborative, engaged, and exceptionally hard working. The creation of the PhD in Cyber Defense has proven to be an excellent administrative decision in that it has increased the overall technical capability of the Cyber Operations students while still allowing a pathway for less technical students to pursue advanced studies in cybersecurity. Areas for improvement would include an increase in the number of faculty supporting the Cyber Operations programs (an initiative already underway); a decrease in faculty teaching load in order to allow time for faculty research activity (grants, contracts, and publications); create an expectation for student publication prior to graduation (not currently the case); and a decrease in the expected volume of faculty dissertation guidance (it appears that current faculty are guiding a large number of PhD students). No changes to the curriculum are recommended. The student support structure is commended for its excellent operation. The creation of a Vice President for Research and Economic Development is a very positive step forward for DSU but is limited in its success due to research capable faculty not having the time to perform typical research activity.

8. Specific issues identified by the university: program curriculum, program assessment, and program enrollments: There were no specific issues identified by the university with respect to curriculum, assessment, and enrollment. Enrollment seems to be on track since 2019 with the creation of the alternative PhD in Cyber Defense. Assessment is satisfactory. Curriculum is consistent with other Cyber PhD programs – particularly for the few that are focused on Cyber Operations. The university is trying to increase the number of cyber operations faculty – but finding such talent is a struggle that all cybersecurity focused programs face. Overall – DSU is doing an outstanding job with the Cyber Operations program!

Part 4: Recommendations for Change

1. General comments: DSU has a nationally recognized program and one highly regarded by the Department of Defense. The program is producing “industry ready” students with a very applied set of skills. The selection process for students entering the program is rigorous and results in highly capable students that are primarily already employed and geographically distant from DSU – therefore, a superb IT infrastructure, a dedicated faculty, dedicated and supportive administration and excellent student services facilities are necessary. DSU has all of these.

2. Specific recommendations relative to focus areas in Part 3: While the current program is excellent – it can always be improved. Specific recommendations for improvement are:

- Increase the number of tenured/tenure track faculty. The current faculty have an exceptionally high workload in teaching and dissertation guidance.
- Require PhD students to publish. Currently this is not a requirement but should be in any PhD program. While DSU focuses on the student research and production of a dissertation – they should also require the student to publish in peer reviewed venues appropriate to the discipline.
- Consider increasing the student dissertation committee to include a member external to the Cyber Operations program. This is a normal requirement in other PhD granting programs.
- Reduce the teaching load with a target of a 2/2 split (Fall and Spring) with the expectation of funded research activity.

3. Specific recommendations relative to issues identified by the university: The issue of allowing international students to participate in the Cyber Operations PhD was discussed and is a decision that the university should eventually take. Other programs across the Nation do not restrict participation to US citizens only as far as the reviewers know. If international students are allowed to participate – the faculty will need to acquire grant funding that supports PhD student research and tuition. The upside to this is that research will likely increase due to the involvement of highly qualified international students being funded to engage in such research. There were no other issues identified by the university.