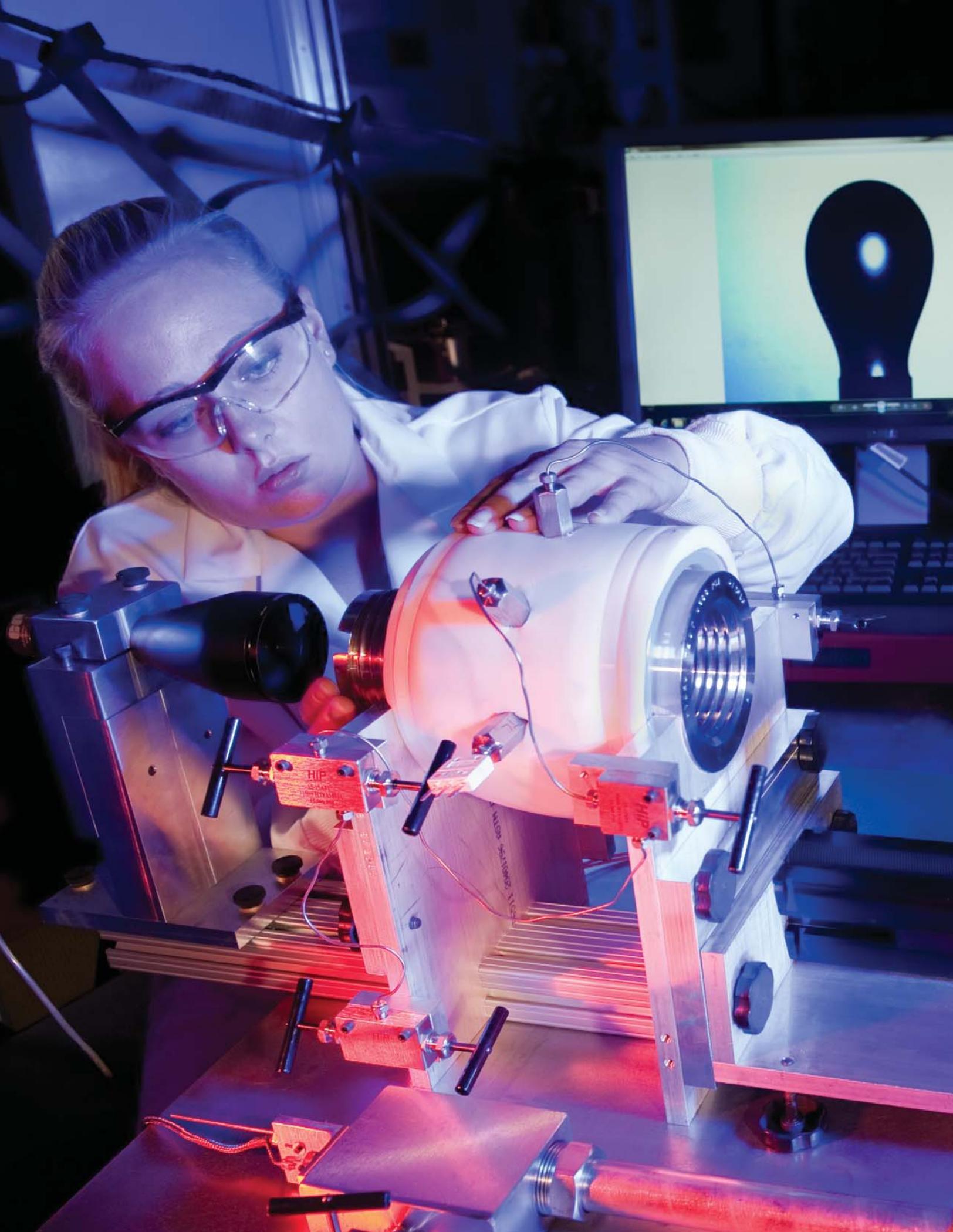




WYOMING GOVERNOR'S ENERGY, ENGINEERING, STEM INTEGRATION TASK FORCE

2012



GOVERNOR'S CHARGE LETTER

MATTHEW H. MEAD
GOVERNOR

THE STATE



OF WYOMING

STATE CAPITOL
CHEYENNE, WY 82002

Office of the Governor

First, thank you for consenting to serve on the Wyoming Governor's Energy, Engineering, STEM Integration Task Force. Given the myriad demands on your time, this is a remarkable commitment to the State of Wyoming and the University. I will work to be respectful of your time and I am very interested in your best thoughts about how to move forward.

It is a top priority for my administration to create the vision to lead the University toward a "Tier I academic and research institution in areas of excellence appropriate for Wyoming." I am committed to 'getting this right' for both the short and long terms and you should consider both time horizons in your recommendations to me.

I have asked former Governor Freudenthal to serve as Chairman of this effort. We are in complete agreement about the importance of this undertaking and the benefits that will accrue to Wyoming. Chad Deaton, Executive Chairman of Baker Hughes Inc., has agreed to Co-Chair the Task Force. Senator Phil Nicholas will join you as a key leader from the Wyoming State Legislature and as another sincerely interested in the direction of this effort.

I have purposely chose the name of this Task Force — the Governor's Energy, Engineering, STEM Integration Task Force — to underscore the synergy that can be developed across the named segments. Investments made by the State, with extraordinary support from private sources, form a solid foundation from which to advance.

From the creation of the UW School of Energy Resources, the relocation of the National Center for Atmospheric Research supercomputer to Wyoming, the construction of the UW-Energy Innovation Center, the creation of the Michael B. Enzi STEM Facility to the defining plans for the UW Energy Engineering Research Facility — Wyoming has already demonstrated considerable commitment to individual areas included in the mission of this Task Force. Now the State of Wyoming is poised to make its most significant investment in the University of Wyoming — the facility for the College of Engineering and Applied Sciences. These investments, including the Engineering and Applied Sciences facility will total more than \$250 million.

GOVERNOR'S CHARGE LETTER (CONTINUED)

As you and I know from our various perspectives, investments today must last longer and continue to be meaningful well into the next generations. What we do here has to be relevant today but also in 100 years.

It is only through a well-articulated, understandable strategy that we will be able to fulfill the challenge of becoming a "Tier-1 academic and research institution in areas of excellence appropriate for Wyoming." Your charge is to develop this strategy.

Your passion and affinity for the University are well known and well demonstrated. I am interested now in your candor and hard-nosed assessment in the development of this strategy. As much as possible I would like you to start from a clean slate in thinking about how best to execute the strategy. I am interested in specificity rather than abstraction. Full characterization will benefit this project down the road as we bring it to legislators and citizens of Wyoming.

Your efforts will ultimately guide an investment of at least \$100 million and one that should influence Wyoming, the University and the generations to come. I do not envision your work to be completed in the next few months nor do I anticipate a 'perpetual' effort. I will be interested in your thoughts on a timeline after you have had a chance to meet in early June.

Your final report should be directed to me, the Joint Minerals, Business and Economic Development Interim Committee, President Buchanan and UW Board of Trustees.

Thank you again for your extraordinary commitment to the University of Wyoming.

Sincerely,

A handwritten signature in black ink, appearing to read 'Matthew H. Mead', written in a cursive style.

Matthew H. Mead
Governor

MEMBERS OF THE TASK FORCE



Dave Freudenthal (Co-Chair)
JD 1980
University of Wyoming

Distinguished Guest Professor of Energy,
Law & Economics,
University of Wyoming &
Former Governor, State of Wyoming

Wyoming Governor Dave Freudenthal joined the University of Wyoming College of Law as a Distinguished Visiting Professor of Law for three semesters starting in spring 2011.

Dave, a Wyoming native, served two terms as Wyoming's 31st Governor. In 2002, as a Democrat and first-time candidate, he won an upset victory in one of America's most overwhelmingly Republican states. After his first term, he was re-elected in 2006 by the greatest percentage in the State's history. By the end of his tenure, Wyoming was ranked as the "Best Run State in America" by 24/7 Wall St., based on a review of hundreds of data sets and a variety of metrics ranging from debt rating agency reports to median income. When he left office in 2011, his approval rating was over 80% ---at the top among all U.S. governors -- and he left his successor with a balanced budget and a billion dollar surplus.

Dave's eight years as Governor were marked by a constructive bi-partisan relationship with a Republican dominated legislature. This working relationship moved Wyoming forward on many fronts. As the nation's least populous state, Wyoming maintains a resource-based economy, relying primarily on mineral and energy extraction, tourism and agriculture for its economic livelihood. Recognizing the strengths and opportunities that this economic base represented for the state, Dave's administration focused on balancing resource extraction and preservation with regulatory approaches designed to enhance long-term growth.



Chad Deaton (Co-Chair)
BS Geology 1976
University of Wyoming

Executive Chairman
Baker Hughes Incorporated

Chad Deaton is Executive Chairman of Baker Hughes Incorporated. Chad served as Chairman of the Board and Chief Executive Officer for seven years starting in 2004 and has been instrumental in the growth of Baker Hughes' global business. He joined Baker Hughes from Hanover Compressor Company, where he was Chief Executive Officer from 2002 to 2004. Previously, Chad spent more than two decades in leadership roles with Schlumberger Oilfield Services, in international and domestic assignments.

Chad serves on numerous boards for companies, as well as industry and community organizations. He is a Director of Air Products and Chemicals, Inc., Transocean and Ariel Corporation. He also serves on the American Petroleum Institute Board of Directors, the Society of Petroleum Engineers Industry Advisory Board, the Offshore Technology Conference Executive Advisory Board, the National Petroleum Council Nominating Committee, the Transocean Ltd. Board of Directors and Houston Achievement Place Board. A native of Wyoming, Chad earned a Bachelor of Science degree in Geology from the University of Wyoming and serves on the Foundation Board and the Wyoming Governor's Energy, Engineering, STEM Integration Task Force.

MEMBERS OF THE TASK FORCE



Dick Agee
BS Petroleum Engineering 1965
MS Petroleum Engineering 1968
University of Wyoming

Founder and Chairman
Wapiti Energy, LLC

Dick Agee is Founder and Chairman of Wapiti Energy, LLC and Bayou Well Holdings Company, LLC. He has more than 45 years of engineering, management, and entrepreneurial experience in both the domestic and international oil and gas industry. Wapiti and Bayou have repeatedly executed rapid growth strategies resulting in the creation of wealth for founders and investors through multiple market cycles.

In 1991, he founded Antara Resources, Inc, which acquired and developed natural gas reserves in the Gulf Coast and Piceance Basin and was sold to Calpine Corporation in 2000. In 1988, he co-founded MetFuel Resources, Inc, and led the drilling of 500 coal-bed methane wells in the Black Warrior Basin of Alabama.

From 1976-1987 Dick worked for Huffco Indonesia, Inc, eventually as acting President of Huffco's large integrated Indonesian enterprise. Dick led this enterprises efforts exploring, producing, liquefying, and transporting Liquefied Natural Gas (LNG) from the island of Kalimantan to end users in East Asia.

Dick holds both Bachelor and Master of Science degrees in Petroleum Engineering from the University of Wyoming, as well as a Master of Science degree in Management Science as a Massachusetts Institute of Technology Sloan Fellow.

Dick serves on the University of Wyoming Foundation Board, and its College of Engineering and Applied Science National Advisory Board. He is a member of the North American Executive Board of the Sloan School at MIT and the Christus Foundation for Healthcare in Houston, TX.



Dave Bostrom
BS Civil Engineering 1968
MS Civil Engineering 1969
University of Wyoming

President
Bostrom Enterprises, LLC

Dave Bostrom owns Bostrom Enterprises, LLC in Worland, Wyoming. Dave spent ten years in the insurance industry as President and Co-owner of Hake Agency in Worland, Wyoming and President and Owner of Insurance Brokerage of Wyoming. He founded and ran MBA of Wyoming, a full service health benefits company, until its sale in 2009.

Dave is the past Chairman and of the Wyoming Business Alliance/Wyoming Heritage Foundation, the former Governor of Rotary District 5440, and a Board Member of Wyoming Sugar Company. He also participated in the Washakie Economic Council, Big Horn Basin Marketing Council, and the Industrial Development Committee of the Worland Chamber of Commerce.

Dave earned both Bachelor of Science and Master of Science Degrees in Civil Engineering from the University of Wyoming and is currently President of the Board of Trustees.

MEMBERS OF THE TASK FORCE



Tom Botts
BS Civil Engineering 1977
University of Wyoming

Executive Vice President,
Global Manufacturing (Retired)
Shell Downstream Inc.

Tom Botts was appointed Executive Vice President for Shell's Global Manufacturing portfolio in March 2009, having previously held the role of Executive Vice President for Shell's Exploration and Production activities in Europe.

A Wyoming native, Tom earned a Civil Engineering degree in 1977 and joined Shell Oil Company in the same year in Ventura, California, as a production engineer in the upstream. Tom worked his way up, holding positions as Division Engineer, Division Engineering Manager, Division Operations Manager, Manager of Corporate Planning and Treasurer of Shell Oil.

Tom moved to London in mid-1998, and then to Scotland in 2001, holding positions as UK Gas Director, UK Oil Director and UK Managing Director. During his time in the UK he was also Chairman of Step Change in Safety, and a member of the Industry Leadership Team and PILOT (the Industry/Government cooperative body in the UK). In October 2003, Tom moved to The Netherlands and became Executive Vice President for EP Europe, leading Shell's largest E&P unit with activities across Europe.

Tom currently serves on the Board of Directors for EnPro Industries, and the National Association of Manufacturers, and is a member of the American Petroleum Institute Downstream Committee, is on the Council of Overseers for the Jones Graduate School of Business at Rice University, and is a long standing member of the Society of Petroleum Engineers.



Tom Buchanan
MS Recreation &
Park Administration 1975
University of Wyoming

President
University of Wyoming

Tom Buchanan's career in higher education has spanned more than 35 years, as a student, teacher, and administrator. A native of New York, Tom attended the State University of New York at Cortland where he graduated with his undergraduate degree in 1973. He earned his Master of Science degree from the University of Wyoming in 1975 and a Ph.D. from the Institute for Environmental Studies at the University of Illinois at Urbana-Champaign in 1979.

After completing his doctorate, Tom returned to Wyoming as an assistant professor in the Department of Geography at the University of Wyoming. Over the next 30 years, he rose through the faculty ranks to full professor, and has held various administrative positions including Department Head, Associate Dean of the College of Arts and Sciences, and Vice President for Academic Affairs. On July 1, 2005, he was appointed the 23rd President of the University of Wyoming.

As UW President, Tom's priorities for the University have included excellence in academics, promoting access to higher education in Wyoming, and enhancing economic and workforce development in Wyoming.

MEMBERS OF THE TASK FORCE



Greg Hill
BS Mechanical Engineering 1983
University of Wyoming

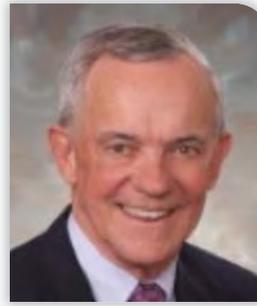
Executive Vice President and President,
Exploration and Production
Hess Corporation

Greg Hill is Executive Vice President of Hess Corporation, a global integrated energy company based in New York City, as well as their President of Exploration and Production. He joined Hess in 2009 and is a member of the company's Board of Directors.

Previously Greg spent 25 years with Shell in a variety of operations, engineering, technical and business leadership roles in the Asia-Pacific region, Europe and the United States. From 2006 to 2008, Greg was Executive Vice President – Exploration and Production of Singapore-based Shell Asia Pacific, a region that included the Philippines, China, Malaysia, Brunei, Indonesia, Australia and New Zealand. During that time he also served as chairman of the company's Global Production Leadership Team. From 2003 to 2006, Greg was Vice President of Production for Shell E&P Europe, which was Shell's largest producing region. He led company-operated assets in the U.K., Norway and the Netherlands from a base in Aberdeen, Scotland. Prior to that leadership role, Greg led the merger of Enterprise Oil into Royal Dutch Shell in 2002 and 2003.

Greg served as Senior Vice President of Aera Energy, a California-based joint venture affiliate of Shell and Mobil, from 1997 to 2002, where he was responsible for the majority of the operations of the company. Earlier in his career Greg served as a Vice President in strategic planning in London, Vice President of operations in California, and numerous other leadership roles in government relations, operations and technology in Houston and California.

Greg holds a Bachelor of Science degree in Mechanical Engineering from the University of Wyoming and serves on the University of Wyoming Foundation Board. Greg grew up in Wyoming and lived in Cody, Worland and Casper.



Tom Lockhart
BS Electrical Engineering 1957
University of Wyoming

Wyoming State Representative
Natrona County, HD 57

The Honorable Tom Lockhart has been a member of the Wyoming State House of Representatives since 2001. He is currently the Chairman of the Minerals, Business and Economic Development Committee and a member of the Management Audit Committee, UW Energy Resource Council, Advanced Conversion Technologies Task Force, Energy Producing States Coalition, Energy Council, CSG West – WESTRENDS and the Joint Subcommittee on Federal Natural Resource Management.

Tom spent most of his career in Wyoming, retiring in 1998 as PacifiCorp/Pacific Power's Wyoming Vice President and PacifiCorp's Vice President of Engineering and Dispatching. Tom started as a Distribution Engineer for Pacific Power in 1960 and later held leadership positions with both Pacific Power and Black Hills Power and Light. In 1985 he returned to Pacific Power as Director of Power Planning responsible for developing the company's plans for future energy contracts and generation resources. Tom then helped negotiate the merger of Pacific Power and Utah Power and went on to become Vice President of Power Systems for PacifiCorp's Electric Operations.

Tom is a current member of the Casper College Foundation Board and a former Independent Director at Arch Coal Inc. In honor of his retirement from their board in 2011, Arch Coal donated \$25,000 to the University of Wyoming to benefit technology and facilities within UW's Energy Resources Center.

Tom holds a Bachelor of Science degree in Electrical Engineering from the University of Wyoming and an MBA from Portland State University. He was inducted into the University of Wyoming College of Engineering Hall of Fame in 2002.

MEMBERS OF THE TASK FORCE



Eric Marsh
BS Petroleum Engineering 1982
University of Wyoming

Executive Vice President and
Senior Vice President, USA Division
Encana Corporation

Eric Marsh graduated from the University of Wyoming in 1982 with a Bachelor of Science degree in Petroleum Engineering. He has been in the oil and natural gas industry for over 25 years, starting his career with Questar Corporation in Salt Lake City. While working with Questar, he held various positions leading up to Production/Operations Manager for the Rocky Mountain Region in Denver.

In 2000 Eric joined one of Encana's predecessor companies with its initial foray into the Rocky Mountain Region and the U.S. As the lead of the Jonah Field, Eric built a team that, through technical advancements in hydraulic fracturing, advanced Jonah into a world-class natural gas field. Eric was promoted to Vice President of the South Rockies Business Unit in 2002, where he oversaw operations that grew gas production from 30 million cubic feet equivalent per day (MMcfe/d) to more than 500 MMcfe/d in the Piceance Basin, DJ Basin and Uintah Basin of eastern Utah. The business unit acquired over one million acres through strategic acquisitions and land sales.

In March 2007 Eric relocated to Calgary to lead the Bighorn Business Unit in the Canadian Foothills Division. His team was responsible for an annual 30 percent growth in production and 150 percent growth in reserve replacement. His business unit conducted the initial high-density drilling and initial horizontal drilling in the Alberta Deep Basin. Eric returned to the U.S. in November 2009 and was promoted to Executive Vice President of Encana Corporation.

In 2011 Eric was appointed Senior Vice President, USA Division to act as second in command of the USA Division and has relocated to Dallas to oversee the Mid-Continent region. He continues to lead the Natural Gas Economy team.

Eric sits on both the Foundation and College of Engineering & Applied Science Boards of the University of Wyoming as well as the Canadian Natural Gas Initiative Executive Committee. He also serves on the America's Natural Gas Alliance (ANGA) Executive Committee and chairs the ANGA Cross-border Committee.



Phil Nicholas
JD 1979
University of Wyoming

Attorney, Nicholas & Tangeman, LLC
Wyoming State Senator,
District 10 – Albany County

Phil Nicholas received his Bachelor of Science in Microbiology from Oregon State University and his J.D. from the University of Wyoming. After graduating in 1979, he first clerked for a Wyoming District Court Judge, and then served for two years as an Assistant Attorney General for the State of Wyoming. Phil entered into general practice in Laramie, Wyoming in 1982, representing individual, corporate and government clients. He has broad litigation experience representing individual parties and corporate clients. His practice concentrates in trial and appellate work.

Phil is admitted to practice in Wyoming, Colorado and Oregon. He is admitted before the United States District Courts for the Districts of Wyoming, Colorado and Northern District of Illinois (General and Trial Bar); the United States Court of Federal Claims; the United States Courts of Appeal for the Tenth and Federal Circuits; and, the United States Supreme Court. Phil is a member of the Wyoming, Colorado and Oregon State Bar Associations, the Wyoming Trial Lawyers Association, the American Bar Association and the National Association of Bond Lawyers.

At the State level, Phil served eight years in the Wyoming House of Representatives and is currently an elected member of the Wyoming State Senate. He has served on the House Judiciary Committee, House Revenue Committee, the House Travel, Recreation and Wildlife Committee, and on the House Rules and Procedures Committee. His final assignment in the House was as Chairman of the House Appropriations Committee. Phil is now serving as Chairman of the Senate Appropriations Committee and is Co-Chairman of the Joint Appropriations Committee.

At the local level, Phil previously served on the Albany County Hospital Board of Trustees, the Laramie Area Chamber of Commerce Board, the Albany County Planning Commission and the Laramie Economic Development Corporation. He is presently Co-Chairman of the Laramie Beautification Committee.

EXECUTIVE SUMMARY

Governor Mead created the Energy, Engineering, STEM Integration Task Force in May of 2012 to address the challenge set forth by the Wyoming State Legislature in House Bill 121 which called for an *“approach to lead the University towards a Tier 1 academic and research institution in areas of excellence appropriate for Wyoming”*. He charged the Task Force to develop a *“well-articulated, understandable strategy that will enable us to fulfill the challenge of becoming Tier 1”*.

Governor Mead was very interested in integration and synergy. He cited the significant investments already made at the University in the areas of energy, engineering, computational capacity, science, technology and mathematics as providing a solid foundation for moving forward. We interpreted his notion of integration to include programs as well as physical facilities.

At the core of this effort is a single fundamental question—**“Why invest my time and money at the University of Wyoming?”** We believe this question must be answered for students, faculty and staff, the private sector and, the citizens of Wyoming as represented by their elected leaders who ultimately allocate State resources. A successful strategy leading to Tier 1 must tie these groups together in an integrated, synergistic manner.

The strategy must be executable and take into account the competitive landscape as well as our finite set of resources both human and financial. We strongly believe that while we don’t have the same resource base as many well-known engineering schools this should not stop us from pursuing Tier 1 status. It does mean, however, that prioritization of our resources is absolutely critical. Without a full understanding of making hard choices and staying the course by all relevant stakeholders both within the University and beyond, the effort will be disappointingly unsuccessful. Determined leadership from all sectors is key.

Our recommended strategy has two primary elements—a “rock solid” undergraduate degree program and a highly focused graduate effort in three to five “niches” where UW can genuinely excel. The full report includes the characteristics we believe ought to be considered in choosing these graduate niches. We list some possible candidates but those choices belong to the University.

Below are a number of specific recommendations, which fall into eight categories that we believe support the strategy. Please note, we believe these recommendations need to be considered as a unit and not separable. This is not a buffet. Executing only a couple of recommendations and not the entire package in our judgment will only lead to frustration and little success.

As you read the full report, you will notice the bulk of our discussions focus on programs and not facilities. This is reflective of both our discussions and our belief that what happens inside the building is paramount to our goal of achieving Tier 1 status. In fact, we advocate programmatic changes should be well on the way to implementation and integrated into building design features before any large scale groundbreaking takes place.

We recognize a number of these activities are already underway at UW but we believe a rigorous re-examination in light of the Tier 1 goal with credible metrics is in order.



Our recommended strategy has two primary elements—a “rock solid” undergraduate degree program and a highly focused graduate effort in three to five “niches” where UW can genuinely excel.

SPECIFIC RECOMMENDATIONS:

DEFINE AREAS OF EXCELLENCE

- » Choose three to five niches and go
- » Consider a series of workshops with CEOs and other industry representatives to focus on timely, significant niches
- » Market University successes
- » Focus graduate programs on niche areas
- » Reassess undergraduate curriculum to match with niche efforts
- » Establish metrics and use them to benchmark accomplishment

IMPROVE INTEGRATION ACROSS COLLEGES AND FACILITIES

- » Change leadership structure to include reward for integration and collaboration
- » Consider restructuring as needed to provide integration and accountability
- » Address inter-program jealousies
- » Niches become the aligning vision which drives integration
- » Establish unified presence externally

IMPROVE AND ENHANCE UNDERGRADUATE CURRICULUM

- » Include practical experience for students
- » Improve communication skills – both writing and speaking
- » Consider greater exposure to business and finance
- » Encourage practical, field-based experience for faculty
- » Encourage field-based sabbaticals for faculty

IMPROVE THE NUMBER AND QUALITY OF FACULTY

- » Aggressively pursue emerging and promising faculty (within current faculty and around the world)
- » Build bench strength especially in niche areas
- » Desired faculty traits: entrepreneurial attitude, willingness to collaborate
- » Create, strengthen and maintain connections with industry

IMPROVE INFLOW OF QUALITY STUDENTS

- » Shift focus of metrics to compare scores (ACT and others) with other Tier 1 schools
- » Focus on National Merit Scholars in order to increase the number attending UW
- » Early partnering with Wyoming high schools and community colleges
- » Outreach to external high schools, particularly on the Front Range
- » Global recruiting and diversity
- » Generous scholarships
- » Provide unique internship opportunities

IMPROVE CONNECTIONS WITH INDUSTRY AND ALUMNI

- » Develop authentic connections with relevant industries
- » Placement of graduates and interns as a key metric
- » Internships are a high priority
- » Leverage alumni networks
- » Alumni mentoring

EXECUTIVE SUMMARY

INVEST IN FACILITIES, WHICH PROVIDE FOR THE ABOVE-MENTIONED INITIATIVES

- » Ensure integration of facilities currently under construction
- » Create a physical environment which will attract young students and faculty (the “Wow” factor)
- » Continue to accumulate \$30-\$40 million per year in the 2013 and 2014 Legislative Sessions, but do not authorize construction until a fully developed integration plan and design is supplied to the Legislature
- » Niche areas get priority on space allocation
- » Allocate funds to ensure sustainability of healthy programs and equipment



Executing only a couple of recommendations and not the entire package in our judgment will only lead to frustration and little success.

LEADERSHIP, EXECUTION AND ACCOUNTABILITY

This is a substantial amount of work to accomplish but in the judgment of the Task Force worth the effort to attain Tier 1 status. Make no mistake; this will require a great deal of focus, prioritization and even sacrifice.

Finally, the Task Force and President Buchanan have identified work yet to be completed over the next several weeks. The objective is to have this work done by February 18th. The University is tackling the first eight items in the list below and the Task Force the last item. The list is as follows:

- » Timelines – attaching timelines and milestones to the recommendations
- » Accountability – assigning the accountable administrators to tasks
- » Niches – identifying three to five niche areas to pursue
- » Metrics – providing comparative metrics that would be used at other Tier 1 schools
- » Integration – providing current approaches and examples of integration in CEAS
- » Motivation - identifying the internal UW drivers for becoming Tier 1
- » University Plan 4 – examining how the ideas in this report might fit with UP4
- » Creative thinking – understanding what initiatives are already underway at UW
- » Legislative leadership – substantive discussions regarding pursuit of Tier 1



While the triggering event for creation of this Task Force was a much-needed focus on the College of Engineering building, most of our deliberations and study were devoted to programmatic issues and not to detailed building design.

1) INTRODUCTION:

Governor Mead's letter of appointment and charge, issued to Task Force members in May 2012, referenced a challenge set forth by the Wyoming State Legislature in House Bill 121 Section 1 (e) (i) which called for an "approach to lead the University towards a Tier 1 academic and research institution in areas of excellence appropriate for Wyoming." The context for this legislative language is the call for the "development of the parameters for the renovation and reconstruction plan for the college of engineering...."

Governor Mead enhanced the charge by calling for a "well-articulated, understandable strategy that will enable us to fulfill the challenge of becoming a Tier 1 academic and research institution in areas of excellence appropriate for Wyoming." He wisely mandated the parameters for the construction proposal include the integration of the ongoing university efforts in energy, the Science, Technology, Engineering and Math facility (the Enzi Building) and related activities. We interpreted this to mean outlining a strategy for progress and change leading to Tier 1 status. We remain mindful these are simply recommendations. We also understand these recommendations carry with them a fundamental questioning of "business as usual" at the University. Only the University's appointed leadership and the State's elected leadership can decide to actually move the State forward.

While the triggering event for creation of this Task Force was a much-needed focus on the College of Engineering building, most of our deliberations and study were devoted to programmatic issues and not to detailed building design. Function should drive form. A building's design should facilitate the activities within and accommodate the integration of those activities with related University programs beyond the walls of the College of Engineering.

You will see programs referenced in nearly all of our specific recommendations. We do believe the facilities should, in addition to being integrated as called for by the Governor, serve all stakeholders and be reconfigurable going forward. The Governor purposefully named the Task Force the Energy, Engineering, STEM (Science, Technology, Engineering and Math) Integration Task Force, reflecting his belief in the possibilities of genuine synergy among not only physical facilities but programs as well. We strongly support this view.

We gained a new appreciation for the many meanings of "integration." We see integration as a means to address organizational efficiency, leveraging assets and creating synergy. The process of integration can be the mechanism for breaking down traditional silos, which will be important, moving forward. There is simply no substitute for the ability to authentically

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collaborate across traditional boundaries and traditional approaches. Successful private corporations and organizations have learned these lessons and changed their strategies and operations. These changes have not been without difficulty but they have been essential to corporate survival.

Task Force members have become painfully aware of the institutional resistance to change. There is a tendency to view every question or recommendation as an indictment rather than an opportunity for constructive dialogue. We understand the enormity of the challenge and difficulty of progress on the numerous recommendations we propose. However, we owe future generations of students, the University and the State of Wyoming our best efforts, lest UW be left behind in a changing world.

The Governor cited the very significant investments already made at the University in the areas of energy, engineering, computational capacity, science, technology and math as providing a solid foundation for executing the integration strategy. We heartily concur and believe UW is in a very strong position to excel.

Finally, it should be noted that the private sector members of the Task Force and their respective companies have significant experience interacting with and recruiting from well-known Tier 1 universities, which we believe adds important context to our recommendations.

As per the Governor's instructions, this report is directed to him, the Joint Minerals, Business and Economic Development Interim Committee of the Wyoming Legislature, University of Wyoming President Tom Buchanan and the University of Wyoming Board of Trustees. A copy of the legislation is attached in Appendix A.

2) OVERVIEW:

At the core of this analytical exercise is a single fundamental question. That question is: "Why invest my time and money at the University of Wyoming?" This question must be answered for distinct groups—students, faculty and staff, the private sector and, last but not least, the citizens of Wyoming or more particularly their elected leaders, the Governor and the Legislators controlling the purse strings. While answers will have particular nuances for

each group, the strategy must tie them together. Hence, the Governor's emphasis on integration refers not only to physical assets like buildings but programmatic efforts as well.

Therefore, in order to be successful, given the University's size both in terms of student and faculty population as well as finite financial resources, integration and cross-functionality are critical to

*At the core of this analytical exercise is a single fundamental question—
"Why invest time and money at the University of Wyoming?"*

achieving the aspirational goal of a Tier 1 College of Engineering and Applied Science. Below, we articulate a specific strategy but we want to lead this report with emphasis on integration, collaboration and good old pulling together for a common purpose. At the end of the day, we simply have no choice but to follow this approach. We have neither the resources, nor the luxury to pursue this goal in any other manner.



It also must be noted that there is a strong foundation and indeed a lot of thoughtful work and effort already underway at the University as evidenced by the recent draft of University Plan 4. We see the Task Force as a necessary evolutionary step to get another set of eyes focused on a common opportunity articulated by the legislature and fully supported by Governor Mead.

Given that academia and the private sector are often different parts of the universe we would expect some discomfort in serious discussions about strategic direction and operational decisions. We view this as healthy and creating an opportunity for deeper understanding and ultimately a more robust effort going forward.

Our charge was to articulate a strategy that we believe appropriate and executable under the proper leadership of the state lead by the Governor, the Legislature and the University represented by both the President and the Board of Trustees. We believe that the successful execution of this strategy will also resonate with the private sector yielding both insightful guidance and potential financial support.

3) THE FUNDAMENTAL QUESTION: WHY INVEST MY TIME AND MONEY AT UW?

STUDENTS:

As alumni, we spent a good deal of time thinking about students both from the perspective of our own time at the University and now as potential employers of graduating students. We thought of engineering students as falling into two basic categories: conventional—those worthy of attention simply by virtue of their pursuit of an engineering degree; and exceptional—those whom we seek out because of extraordinary, demonstrated and desirable talents. We believe that all qualified students should be given the opportunity to participate in a Tier 1 educational experience. However, our bias is to move toward a greater percentage of exceptional students. The answers to the question of why would I go there is likely different for conventional students than exceptional students.

For conventional students, particularly those from in-state and the region, the decision to attend may have been shaped or more properly ought to be shaped by early identification of potential for success in the engineering curriculum. They were thinking about coming

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to UW to study engineering, perhaps for no more compelling reason than because a good program was available to them at an affordable price. For an exceptional student the answer most certainly is different.

Imagine for a moment a graduating high school senior, in Wyoming or elsewhere, who has been accepted to MIT, Stanford, Purdue or the University of Texas. What could help draw that individual to the University of Wyoming? The choice to come to Wyoming will likely involve different criteria than for the conventional student. At a minimum these students will evaluate UW's reputation, its faculty, its research resources, areas of emphasis and successes, its internship opportunities and the availability of financial aid. Additionally, the influence of parents on a younger student's decision can be significant. To be competitive and to aspire to a Tier 1 College of Engineering we must be able to attract a significant and increasing share of the exceptional students. In our view it is worth the time, effort and thought to be able to have that exceptional student choose Wyoming. We know this is a marathon and not a sprint; however we need to recognize the challenges involved with doing this work and get on with it.

FACULTY:

We recognize there are many fine, bright, highly motivated faculty members in the College of Engineering. However, as with any group, it would be naïve to think this was a universal characteristic shared equally by all members of the group. So as we set about to attract additional faculty we again have to answer the question of “why would I go there”? The answer in this context obviously has different dimensions than the answer for students. For students the educational experience will likely be a “career launcher.” For faculty it is the opportunity of a “career changer,” the chance to pursue a top-flight research and teaching opportunity, which could involve peers of significant standing in the field.

For faculty it appears to be a much higher stakes decision because of these career implications. If we assume quality faculty has multiple career choices, the work to attract quality faculty successfully takes on different dimensions. Certainly, long-term support for the engineering program represented by a financial commitment of reasonable magnitude and sustainable certainty would be a necessary — but not sufficient — condition to ensure success. As was pointed out by President Buchanan in one of the discussions it would be nearly impossible to aspire to Tier 1 status with funding that vacillates with the global market price for commodity

energy minerals. This dilemma will undoubtedly take the best minds working thoughtfully and collaboratively from all sectors of leadership to resolve.

BUSINESS COMMUNITY:

Private sector companies look to universities primarily as places to recruit a talented workforce. In some instances companies look to universities for basic and applied research important to their corporate mission. In each

Given that academia and the private sector are often different parts of the universe we would expect some discomfort in serious discussions about strategic direction and operational decisions.

of these roles, companies are pursued by institutions from around the world seeking a share of the company's limited recruitment and research dollars. As you might expect, companies allocate these dollars to the institutions yielding the greatest rate of return, measured in terms of quality employees or the value of important research.



To be blunt, some companies choose to come to UW to gather and employ quality engineering graduates, other companies choose to go elsewhere. The challenge is to elevate the institution and its graduates in the eyes of prospective employers. This is also true with respect to financial investment in research. We believe in many cases this situation can be improved by strengthened relationships between UW and the companies. These relationships can and should be nurtured in the best sense of that word. Our analysis suggests that companies at least in the energy sector establish “go to” universities. The difference in the relationship between these universities and the casual hiring visit are significant.

President Buchanan and many of the Task Force members benefited from several detailed and thoughtful presentations by member companies about their recruitment process and their definition of “go to” recruitment institutions. The conclusion was clear; we must elevate our efforts by drilling down to understand how these company decisions are made and to put ourselves in the best competitive posture. The benefit to the University and the College of Engineering can not only be an understanding of the current state of the art engineering practices in the various sectors but also potentially lead to financial contributions to support research. Additionally, seasoned company personnel might teach, under the appropriate conditions, supplementing faculty and providing a differentiating experience to students.

CITIZENS OF WYOMING:

Wyoming citizens make investment decisions through their elected officials. For the University the purse strings are controlled by the Governor and the Legislature. For them a decision to invest in the University of Wyoming, and more particularly in new facilities for the College of Engineering, means someone or something else goes unfunded. Capital construction funding requests for UW compete with highway projects, community colleges, human services, K-12 education, salary adjustments for faculty and state employees, and so forth. Particularly in tight budget periods, “it’s our turn” may not be an adequate basis for an investment in excess of \$100 million.

We believe the integrated programmatic and physical plant approach called for in the Governor’s letter to the Task Force presents the most compelling case for an investment of this magnitude. It stretches the dollars further, serves students better, responds to the State’s economic priorities, invites private sector participation and moves decisively toward Tier 1 status.

4) THE STRATEGY:

Our recommended strategy has two primary elements. The first is investing to assure a challenging, “rock solid” undergraduate engineering degree. This educational experience should be on par with those at any top-tier university with a solid reputation for engineering programs such as Purdue, Stanford, University of Texas, and the like.

The second element of the strategy is to choose three to five graduate niches at which the University of Wyoming can genuinely excel. These niches ought to be well thought out, conscious choices, not simply a function of available faculty and their interests. The niches should relate directly (at least a number of them) to the state’s existing and future economy. While some of these ought to center on energy studies, a number of them should not.

These are the recommended characteristics for selection of niches:

1. Build on existing research leadership capabilities at UW
2. Answer a market need driven by interests that will fund research and hire graduates
3. Involve research that is important and relevant to the state of Wyoming.
4. Demonstrate the ability to attract talent to UW
 - » Professor level talent
 - » Student level talent, particularly high quality graduate students
5. Have a high probability of success
6. Have a high probability of attracting external funds, both federal and private

At first blush this strategy seems obvious and simple, in some ways reminiscent of the old standby “centers of excellence” discussion. Experience has proven implementation of any strategy involving change is never easy. As reflected in much of the previous discussion, the real work will be in hundreds of decisions at the operational level. Leadership, planning, execution and the determination to stay the course are the keys to success.

Choosing a handful of niches at which the University can claim top rank status will avoid the dreaded characterization as an institution which is a mile wide and an inch deep. The selection of the niches is not a trivial problem given the University’s role as the State’s only major four-year institution. Many groups of citizens have desires for a broad array of degrees and are not shy about expressing their preferences to the political infrastructure.



There is simply no substitute for the ability to authentically collaborate across traditional boundaries and traditional approaches.

Decisions as to the best graduate and research niches are as important as they are difficult. In the modern world, UW cannot be all things to all people. Prioritization is absolutely necessary given the competition—whether it is for students, faculty, or companies. We understand prioritization for personal time and budget, why would we think the University can operate without prioritization? Laser focus and

sustainable commitment are key to moving toward Tier 1 status. Excellence is earned not bestowed.

We provide an example in Appendix B of a promising niche area. The example happens to be in reservoir characterization but combines UW's computational resources with experimental work already underway.



5) THE APPROACH:

Our path to Tier 1 is not for the faint of heart. Nor are the recommended actions separable. This is not a buffet where you pick one from table “A” and three from table “B”. The recommendations should be considered in a holistic manner. Executing only a couple of the recommendations and not the entire package, in our judgment, will only lead to frustration and little long-term success. We believe an “ecosystem” of collaboration and silo-less cooperation should be constructed to nurture and support the College of Engineering and Applied Science. We see this as an all hands exercise with exceptional effort from stakeholders both inside and outside the University. A half-baked effort does not net half-a-loaf, it nets a patently unacceptable result.

It should be noted that the University may say, and in some cases with justification, that “we already know these things and are doing them”. Our response is that may well be true, however the evidence is lacking. No one is suggesting the University has attained the desired level of excellence—certainly not the legislature, given the language of the appropriations bill. This is not meant in a mean-spirited way. Simply, we come from a world where evidence and hard-nosed metrics rule. We believe an evidentiary approach should govern the activities, judgments and ultimately the allocation of scarce resources.

As you have no doubt noticed, we have discussed many things but not the engineering building or facilities. This reflects the nature of our discussions. As a group we have spent very little time on the physical plant other than we believe the facilities ought to support the educational and research activities of the college. This support can occur in the context of buildings designed to discourage “academic cylinders”, siloed discussions, and private empires. We leave it to others to make the specific determinations and recommendations regarding facilities. But the professionals designing the building need to know our priorities. Is our priority the preservation of the status quo or encouraging professors with new ideas, collaborative programs and a desire to excel? Selection of one priority either by explicit decision or benign neglect has very real implications for building design, allocation of space and dedication of resources. We believe strongly the facilities belong to the entire University (as an instrumentality of the State of Wyoming) and should be allocated toward the highest and best use at all times. President Buchanan has provided an excellent framework envisioning facility use by activity. It is attached as Appendix C.

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Finally we also advocate the programmatic changes we suggest should be well on the way to implementation, hopefully maturing, and integrated into building design features before any large scale groundbreaking takes place.

6) SPECIFIC RECOMMENDATIONS:

Following are eight specific recommendations. In some sense we view these as eight areas worthy of improvement throughout the University as well as at the College of Engineering and Applied Science. We fully understand some of these recommendations will “ruffle some feathers.” Such was not our intent. We took our task seriously. Plainly stated, this effort should be done right or not done at all. In the absence of continued, viable, sustained leadership and commitment, we should admit we are willing to “settle for less” and move on.

This umbrella imperative speaks to the timely execution of these recommendations. By this we mean creating rigorous, hard-nosed and honest analysis of the current situation. We must begin with a realistic view of UW’s position relative to true Tier 1 universities. We need accurate benchmarks in order to effectively monitor our progress. This means development of authentic metrics for each recommendation. Following this analysis, realistic planning should be put in place. Planning would include but not be limited to explicit timelines, milestones, resource commitment—both human and financial—and delineation of parties responsible for executing the plan. A regular review of progress would also be part of the plan of execution. A viable progress review will reach beyond the University and include alumni, the business community, legislators, the Governor and the citizens of Wyoming. We recognize that the implementation of these recommendations will take a number of years; however, it should be possible to construct the detailed plans of execution in a matter of months with thoughtful focus. There are many uncertainties, of course, but this should not paralyze an effort to build the action plans for these recommendations.

Specific recommendations are as follows:

i) DEFINE AREAS OF EXCELLENCE:

Areas of excellence or “niches” as we have labeled them are the heart of the graduate program strategy. Even a cursory look at Tier 1 engineering schools suggests that UW does not currently command the resources to be all things to all people. For example, research dollars available to a school like Stanford are in the range of 20 times those available to UW. The same can be said of tenure-track faculty and researchers. However this mismatch of resources should not dissuade us from our aspiration to be a Tier 1 institution. It does mean we necessarily must make



Choosing a handful of niches at which the University can claim top rank status will avoid the dreaded characterization as an institution which is a mile wide and an inch deep.

strategic decisions about where we will choose to invest and ultimately excel.

- *Choose three to five niches and go:* It makes sense to select three to five niches relatively quickly. These niches should represent the intersection of university capability, business relevance, and strategic importance to the state. These niches, once chosen, will also serve as the key aligning “common mission” to drive integration across multiple colleges. College of Engineering would continue to align with these areas of excellence. Consideration should be given to those areas in which UW has comparative advantage such as computational resources (both intellectual and machine cycles), and should take into account the current and likely future economic drivers for the state. We have a bias for the energy industry but believe strongly other niches are certainly appropriate.



It appears to us that a combination of our computational resources with experimental abilities would be a good first order construct to determine possible niches. Again, a rigorous assessment of the competitive landscape with respect to the expertise of competing institutions would make a great deal of sense, along with a proactive dialogue with industry to identify the areas most relevant. Below are examples we discussed briefly:

- » Energy in general but reservoir characterization in particular
- » Computational science
- » Atmospheric science
- » Water Resources Engineering
- » Biomedical and biological engineering
- » Advanced conversion technologies for energy resources, particularly coal and gas

Prominence in these fields also requires strength in supporting areas, such as civil infrastructure, minerals development and industrial control processes.

- *Consider a series of workshops with CEOs and other industry representatives to focus on timely, significant niches:* An effort in this regard could serve two purposes—to aid in the choice of niche determination and be a first step in a renewed effort of relationship strengthening with companies important to the state’s future. We see these conversations as not particularly expensive, relatively easy to organize, and able to be done quickly.
- *Market university successes:* Our sense is there is a lot to brag about already taking place at UW. A professional level marketing and outreach program focused on the accomplishments of the College of Engineering makes sense to us. Again, we see this effort as being one element of a broader integrated approach delivering benefits

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internally to students and faculty as well as externally to prospective students, parents of potential students, elected leaders, national and academic media outlets, and companies.

- *Focus graduate programs on niche areas:* To excel in niche areas, the University will need to focus its financial, human, marketing and outreach resources on the graduate programs in these areas, which will necessarily require attention and resources beyond that which can be afforded to other graduate programs. This is just one reason why the niche areas need to be so carefully chosen. Given our aspirational goal and limited resources we see no other realistic approach.
- *Reassess undergraduate curriculum to match with niche efforts:* We argued above for a “rock-solid” undergraduate degree program. And that is our first priority. However, when opportunities present themselves the University should align the undergraduate engineering degree with these graduate niches to facilitate integration and consistency.
- *Establish metrics and use them to benchmark accomplishment:* Rigorous quantitative and qualitative data must be collected and analyzed to determine progress and identify both successes and challenges. We see this as standard operating procedure for all of our recommendations. This is not a single event but must be woven into the culture as we move toward Tier 1 status.

ii) IMPROVE INTEGRATION ACROSS COLLEGES AND FACILITIES AT UW:

Consistent with our strong belief in integration as an organizing principle for the effort to attain Tier 1 status we believe this has broad application across the campus. It is important to understand that we need to move quickly from the abstract notion of integration to its day-to-day practice. Indeed, an important element will be the use of the niches to drive a common mission or sense of purpose across multiple silos. Said differently, the niches will become the “moon shot” that inspires collaboration to achieve something important and extraordinary. The recommendations below reflect conversations we have had surrounding application of the notion.

- *Change leadership structure to include reward for integration and collaboration:* This recommendation reflects our belief that moving from the abstract to daily practice of integration will require reinforcement. Planting this imperative squarely in the minds of those responsible for the daily operation of the University makes sense to us. This should not be a casual bolt-on consideration.

It is important to understand that we need to move quickly from the abstract notion of integration to its day-to-day practice.

- *Consider restructuring as needed to provide integration and accountability:* If we are to truly aspire to Tier 1 status, we need to employ all means available to us to be goal focused. We must set the conditions such that the University has the best opportunity to succeed.

A conversation about restructuring focused on integration and accountability will allow for a vigorous debate of how to proceed. We were struck by the adverse reaction to the suggestion the University look at greater integration of the geology and petroleum engineering programs. This type of programmatic integration is the hallmark of several nationally recognized programs. Apparently, not only is this in danger of not happening at UW, it is difficult to even discuss the possibility. Yet in order to accomplish this essential integration, the University must emphasize linkages among disciplines. Through the niche areas, the college should tap additional expertise in Geology and Geophysics, Mathematics, Chemistry, Economics and Finance, and Life Sciences, via collaborative processes common in corporate settings.



- *Address inter-program jealousies:* This unfortunate circumstance is founded on the clear perception that some departments have worked to submarine efforts to build successful programs elsewhere on campus. In other words, “if we don’t get it, we don’t want them to get it, either.” This mindset was evident as significant resources and attention were directed toward the School of Energy Resources in recent years. Only recently has the thinking begun to mature to a grudging recognition that a strong SER offers benefits to other colleges at UW. It would help to skip the jealousy stage, and move directly to the stage of embracing the possibility of success, and the value it brings to the University as a whole.
- *Niches become the aligning vision, which drives integration:* We believe selection of these niches will provide a working model of integration at an operational level. Using the initial niches will provide an opportunity to work out the operational kinks and refine integration going forward. We should keep in mind this is a relatively new approach, particularly at this scale. To some degree, we are all learning how to execute the concept of integration, and therefore should not expect perfection in the first iteration. We believe strongly that if we are able to demonstrate—to the external world and to ourselves—a high degree of integration synergy, we will have gained a significant advantage over other institutions. Resources will always be constrained relative to demand. The only consistent way to extend the value of current resources and attract new ones (governmental or private) is to use them more efficiently through priority-setting, collaboration and silo destruction. In this manner UW becomes a more attractive place to invest time and money.
- *Establish unified presence externally:* We believe the payoff for the effort of diligently pursuing and demonstrating integration will manifest itself in external relationships and the opportunities that flow from these external parties. For example, if we can justifiably claim the efficiencies and synergy of integration, we make UW more competitive for external funding from companies as well as other institutions. We also believe this

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demonstrated ability will be an attractor for both students and faculty, and may also give us a significant advantage for the placement of both interns and graduating engineers—if these students can legitimately claim they have experience in an integrated system.

iii) IMPROVE AND ENHANCE UNDERGRADUATE CURRICULUM:

This recommendation gets to the heart of the matter regarding students answering the question “why should I attend the UW College of Engineering and Applied Science”? An undergraduate degree in engineering should be comparable to any similar degree completed at any Tier 1 comparator university. This is a high bar but if we are serious it should be set high.

We should be prepared to compare our clearly identified, well-accepted metrics with those of any Tier 1 University in an honest, forthright manner. After all, the exceptional students we are trying to attract will certainly make this analysis, as will their advisors, parents and financial supporters. The same will be true for faculty we propose to pursue and companies with which we will build stronger relationships.

In addition to this rock-solid undergraduate academic experience, the Task Force has given thought to what we call differentiators. We understand the limited number of hours the faculty has to deliver the substance of the curriculum; however, we believe the following would separate UW graduates from those at other institutions:

- *Include practical experience for students:* Based on experience and observation, students with even modest practical experience perform better and are of increased value to the employing organization. Practical experience gives the undergraduate engineer a rich context in which to understand the profession. It also gives the student greater knowledge and confidence in the interview process.
- *Improve communication skills both writing and speaking:* It is hard to overestimate the value of basic communication skills in writing and speaking. We recommend these skills be integrated and emphasized in all undergraduate courses. Any written assignments should be evaluated not only on content and quality of thinking, but should also be graded with regard to written proficiency. Speaking assignments should be treated similarly. Corporations now emphasize team-based, collaborative approaches to problem solving. Experience tells us that, no matter how brilliant you may be, you will not excel as a team member if you cannot communicate.
- *Consider greater exposure to business and finance:* Again this may be difficult given a limited number of credit hours but advisors and the college itself must recognize and promote the concept of

Task Force members have become painfully aware of the institutional resistance to change...However, we owe future generations of students, the University and State of Wyoming our best efforts, lest UW be left behind in a changing world.

business acumen as a valuable differentiator for newly minted undergraduate engineers.

- *Encourage practical, field-based experience for faculty:* It is our belief that practical field experience would be beneficial for faculty as well. The contextual benefit we identified above would be equally true for faculty members. This might also be an avenue to make deeper connections with practicing professional engineers in industry, which we will discuss in a separate recommendation below.
- *Encourage field-based sabbaticals for faculty:* This is a continuation of the recommendation directly above. We would challenge our peers in industry to respond in a substantial way to inquiries made by the University to make the field-based sabbatical a meaningful experience. Organizing this conversation ought to be beneficial to both engineering faculty and practicing professional engineers.



iv) IMPROVE THE NUMBER AND QUALITY OF FACULTY:

We see the connectivity between improvement focused on curriculum, faculty and students as inseparable parts of a whole. While individual tasks may require different timelines, these three efforts in our opinion must move together. This is one fundamental example of the integration required to be successful. While we have listed these three recommendations separately we firmly believe that integration in the form of communications, coordination and unity of leadership is critical.

With respect to improving the number and quality of faculty we make the following suggestions:

- *Aggressively pursue emerging and promising faculty (within current faculty and around the world):* There is an old saying in the business world that to accomplish great things one needs time, money and talent. This is the talent element. It is not possible to have a rock-solid undergraduate degree without high energy, bright, inspirational and enthusiastic faculty delivering a Tier 1 curriculum. We believe the proper execution of this task is critical. We also believe this is not a cost-free endeavor, particularly given the faculty member's career considerations touched on above.
- *Build bench strength:* As was eloquently pointed out to the Task Force, the University has served as an unfortunate, real-world example of the vulnerability of relying on a single faculty member rather than building a core of 4 to 5 faculty in an area of emphasis. With our recommendation of a small number of "niches" in graduate study areas, this becomes particularly important. It makes sense to consider and implement

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these areas of excellence from the point of view of sustainable strength rather than opening ourselves to unnecessary vulnerability by not funding or populating these areas with appropriate levels of outstanding faculty and essential staff. The University estimates an annual faculty, staff and support budget requirement for each niche to be approximately \$1 million, with total additional initial startup costs of \$8 million. The Task Force has some concerns with these estimates, and we feel ongoing costs may be higher than the University's estimates.

- *Desired faculty traits:* We believe there are two overriding traits that ought to be existent and reinforced in faculty be they existing or new. These are an entrepreneurial attitude and a willingness to pursue collaboration across academic boundaries. Entrepreneurial attitude, in our judgment, has to do with inspiration and enthusiasm exhibited for the benefit of students. After all, engineers solve problems. Students should be exposed to faculty with a solid sense of identifying emerging problems and pathways to their resolution.

A willingness to pursue collaboration across academic boundaries is part and parcel of another aspect of integration. As we all know, the world is not organized in convenient sectors. The complexities we see today cry out for collaboration and nonconventional thinking. We believe modeling this in the classroom via exceptional faculty is important for student growth and understanding.

- *Create, strengthen and maintain connections with industry:* Below we will dedicate a specific recommendation to this topic. However, we believe it is of sufficient importance that we wanted to mention it in the context of the faculty recommendations. Authentic industry partnerships—in the best sense of this phrase—are highly desirable.

v) IMPROVE INFLOW OF QUALITY STUDENTS:

Students, of course, are the third component to this effort along with curriculum and faculty. A necessary condition of any Tier 1 engineering school is high-quality students. It should be no different at UW. We offer a number of ideas, many of which we believe the University likely already has in place. However we believe revisiting these efforts with a concentration on metrics and an increased leadership focus would be beneficial.



Operational execution here can be built on the existing foundation; reinventing the wheel is not required. We can start immediately.

- *Shift focus of metrics to compare scores (ACT and others) with other Tier 1 schools:* This of course has to do with external metrics and bringing quantitative focus to student quality. We recommend a serious look at the gap, if there is one, between incoming UW engineering students and those of other Tier 1 engineering schools. We recognize and embrace the notion that UW needs

to give all students an opportunity to attempt the engineering curriculum. However, we also believe that the combination of a more rigorous curriculum and high-quality faculty should and will require significantly increased performance in order for a student to remain in the engineering program.



- *Focus on National Merit Scholars in order to increase the number attending UW:* Again, we believe the University is likely making an effort in this arena. However, we believe aspiring to Tier 1 status requires out-of-the-box thinking. We envision recruiting the most promising engineering students to be akin to pursuing the most promising athletes for UW teams. In addition, a particular emphasis should be placed on recruiting Wyoming high school students since the existing Hathaway Scholarship program provides such significant assistance with college costs. The University should also recognize the potential value of stepped-up efforts to involve advisory boards in the recruiting process.
- *Early partnering with Wyoming high schools and community colleges:* This effort will require authentic partnerships with the best teachers and faculty in Wyoming's high schools and community colleges. The folks in these schools are in the best position to identify the most promising students. In some cases those very students may not have the highest standardized test scores; instead, they have shown an aptitude and a willingness to work hard. A solid, long-term relationship with the key people who are in a position to lead us to those less-than-obvious students is a must. Here again, success will be driven by the relentless execution of a rather obvious idea.
- *Outreach to external high schools, particularly on the Front Range:* Through time, in the process of finding quality students, the University will necessarily have to expand its area of recruiting to a more regional effort. The Front Range is a logical first step, but we should also think big. The thinking and therefore the organizational effort should accommodate students from the United States and across the globe. Engineering graduates, after all, will likely find themselves in all parts of the world throughout the course of their careers.
- *Global recruiting and diversity:* Observation suggests that UW already has substantial global reach in terms of both students and faculty. This is an excellent foundation on which to build further growth. Diversity achieved through this effort will enhance the understanding and ability for engineering graduates to be successful no matter where they find themselves geographically. We believe this to be true not only for the energy sector but for other engineering niches chosen by the University.

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- *Generous scholarships:* For the exceptional student who might have been accepted to programs such as Princeton, Purdue, Stanford, MIT, University of Texas and others, available financial support could likely be a deciding factor. The University of Wyoming's ability to compete in this arena will become increasingly important. This, of course, requires substantial financial commitment and marketing of the college's programs at the national and international levels to ensure visibility, stimulate opportunities, and to promote recruitment of the most talented students to the emerging Tier 1 engineering program.
- *Provide unique internship opportunities:* This notion is another example of the benefit of genuine integration. As mentioned above, if faculty and staff members have created relationships with industry partners, the ability to place students in unique internship opportunities is greatly enhanced. This can also be part of the recruiting narrative in the outreach efforts to high school and community college students. Additionally, the feedback loop between the faculty and host internship provider creates the opportunity for a better experience for all participants, including the student.

Operational execution here can be built on the existing foundation; reinventing the wheel is not required. We can start immediately.

vi) IMPROVE CONNECTIONS WITH INDUSTRY AND ALUMNI:

As might be expected from a private sector oriented group of UW alumni, this idea is at the top of our minds. We see great opportunity to significantly enhance this effort and to reap the benefits of doing so. We have the following specific suggestions:

- *Stay current on changing industry practice:* Students graduating from the engineering program who do not go on to graduate school or academia will find themselves working in industry. The more current they are with contemporary industry practice, the better they will be able to perform and advance. A relevant example is horizontal drilling—a situation where industry practices are well beyond those that are being taught in nearly all universities. If the bulk of our students' preparation is in traditional drilling they will be at a severe disadvantage when they show up for work. Having both faculty and students familiar with current industry practice is beneficial in the classroom and laboratory as well as in the job interview.

Mining this extraordinary, experienced human resource with the perspective gained by years of service will be well worth the effort.

- *Develop authentic connections with relevant industries:* Connections can take many forms and may be different for different industries important to the engineering program. Understanding the nuances of each industry is important in order to optimize the benefits to all parties—University, company, faculty, student and staff.

We believe so strongly in these connections that we suggest this activity be an element of the job description for faculty. The benefits are many.

First, strong connections would reveal the state-of-the-art as practiced in industry and as advanced in sister academic institutions. Being conversant at the leading edge is a condition for being a Tier 1 institution.

Second, the conversations resulting from these strong connections will likely lead to bolstering both research topics as well as funding opportunities. From the example above, efforts to secure funding for a research effort involving traditional drilling practices would likely not only be unsuccessful, but might bring into question the relevance of the current engineering program as a whole.

Finally, strong authentic connections would lead to robust internship and field opportunities for students, faculty and staff, as mentioned above.

All of these are examples of the synergy of integration. All speak to the idea that these efforts ought to be undertaken simultaneously under a unity of understanding and purpose.

- *Placement of graduates and interns as a key metric:* Again, in an effort to quantify both the current situation and measure progress we recommend a serious effort as to the placement of graduates and interns. The University and the College of Engineering leadership as well as the individual engineering departments all ought to know the detailed status of their graduates and these graduates' progress. This ought to be equally true for interns. Placement and status should not be empty statistics, but should feed back into programs, recruiting, outreach and curriculum design. The analysis should begin prior to the student's entry into the program and extend several years beyond graduation. We believe this effort will yield benefits many times the cost and, in fact, will gain value through time.
- *Internships are a high priority:* The ability to generate high-quality, significant internships can be a key differentiator for the UW engineering program. This may be one instance where our smaller size, in comparison to other Tier 1 programs, ought to work to our advantage. We are not so large as to have students disappear into the masses. If we are able to take advantage of the synergy of integration as suggested in a number of the recommendations above, internships will move into a normal part of the engineering educational process at UW.
- *Leverage alumni networks:* We view the alumni as an underutilized yet highly loyal resource. We therefore recommend a large, focused effort to identify and engage alumni, particularly those with engineering or related science degrees. By this we mean moving well beyond the "apple pie and motherhood" approach of an institution



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connecting with graduates. These alumni know the value of their engineering degree, the state-of-the-art in their particular industries and the attributes valued by their respective companies or academic institutions.

Mining this extraordinary, experienced human resource with the perspective gained by years of service will be well worth the effort. We recommend as a first step studying those institutions that we believe are the best in the business. A first-rate example is Texas A & M University. We do not recommend replicating the A & M scheme, but rather studying it and adapting practices apropos to UW. This effort will require financial and human resources; however, the benefit and the opportunity to differentiate the UW engineering program should outweigh the cost.

- *Alumni mentoring:* One specific idea for successfully leveraging alumni networks would be the establishment of an alumni mentoring program. Who better to enlighten students, interns and recent graduates than alums working in their profession? Our sense is that “Poke Pride” extends into the business world and could give UW graduates an advantage regardless of the path they choose. Studying those institutions with the best practices can save start up time and avoid missteps. It also makes sense to utilize willing alumni in the outreach effort to recruit high-quality students in high schools and community colleges in Wyoming and beyond.

vii) INVEST IN FACILITIES WHICH PROVIDE FOR THE ABOVE-MENTIONED INITIATIVES:

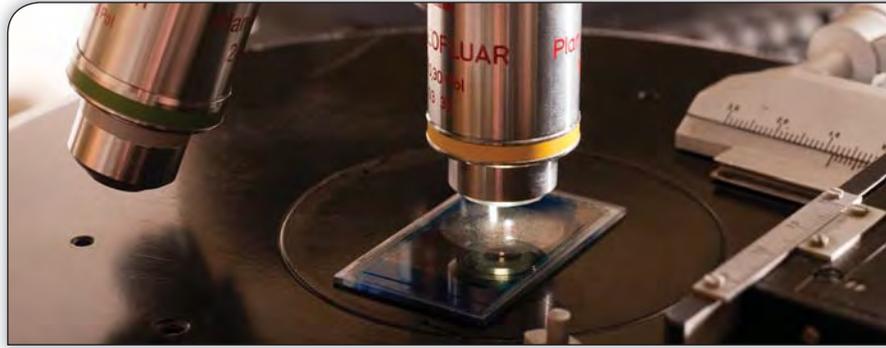
As executives for our respective companies we are very familiar with long-term investments, strategic plans, capital budgets and operating budgets. The Legislature’s proposal for significant investment in new engineering facilities is remarkable in its scope and scale. This alone calls for careful management of the process. However as we contemplate the charge issued to the Task Force by Governor Mead, the mission to recommend a pathway to a Tier 1 engineering college becomes even more daunting. Nonetheless, to a person we are very excited and enthusiastic about the opportunity.

As was mentioned several times above, this mission is more than a discussion of physical facilities. Nonetheless, we do have some perspectives and recommendations for investment in the facilities.

The aggressive nature of our recommendations with respect to pace and performance also suggested a review of administrative skill sets be conducted for positions responsible for accomplishing key tasks.

- *Ensure integration of facilities currently under construction:* With the completion of the Energy Innovation Center, the pending construction of the Michael B. Enzi “STEM” laboratory facility and consideration being given to the “high bay” Energy, Engineering Research Facility, it makes sense to ensure these buildings foster the concept of integration. Again, we believe strongly in directing these facilities to the

highest and best use for the State of Wyoming, the University and the College of Engineering. We are very curious to understand the allocation of space process in these aforementioned facilities. Perhaps the matrix framework in the appendix can provide a starting point for this discussion.



- *Create a physical environment which will attract young students (the “Wow” factor):* While many of us have not been students for quite some time, we understand the attraction of a truly stunning building. Perhaps the best on-campus example is the new College of Business building. It is difficult not to be drawn back to that building once you have experienced it.
- *Continue to accumulate \$30-\$40 million per year in the 2013 and 2014 Legislative Sessions, but do not authorize construction until a fully developed integration plan and design is supplied to the legislature:* This recommendation and the two that follow are more in the vein of practical reality. Of course this notion is subject to the direction of the Governor and Legislative leadership, but it seems reasonable—given the state’s fiscal situation and the unfortunate Congressional handling of the Abandoned Mine Land funds—that we should proceed cautiously.
- *Niche areas get priority on space allocation:* In keeping with our suggested strategy, we recommend the niche areas be considered as critical to long-term success. Therefore, the space required for these activities would gravitate to the top of the allocation list. This recommendation helps bring into focus the need for a thorough, well developed program plan. One cannot allocate space to niches if they have not been selected.
- *Allocate funds to ensure the sustainability of healthy programs and equipment:* It is important to understand that capital investment is only one component of a sustainable program. Buildings require maintenance and upkeep, and equipment requires replacement. As we came to understand, personnel costs are the largest expense in a university operation. Given this, the University must account for capital and operational costs as it approaches an effort to reach Tier 1 status. In our judgment it would be folly to focus only on the immediate capital investment. We recommend creation of a long-term (at least 10 year) budget that captures capital expenses, operating and maintenance expenses, equipment replacement, standard personnel cost and the costs of initiatives recommended in this report. Only then will we be able to make a rational decision about our aspirational goal and what it will really take to get us there.

viii) LEADERSHIP, EXECUTION AND ACCOUNTABILITY:

We view this undertaking as a nontrivial, long-term initiative of great importance. In our minds this is not business as usual. We have called for significant analysis, planning,

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decision-making and operational execution. We understand that the best conceived plans are close to meaningless without committed leadership. Who does what by when and how is a simple abstract concept. Execution makes all the difference. As this initiative is reviewed in the months to come, leadership will be the determinant factor above all else. We also believe despite the enormity of the challenge, Wyoming is in an extraordinary position. Few if any states can claim the unity of vision found in Wyoming. Genuine support from Governor Mead, the Legislative leadership, the Board of Trustees of the University and the University President appear to be in alignment toward the aspirational goal of becoming a Tier 1 engineering school. Differences likely exist in the operational priorities and sequencing, however there does not seem to be significant disagreement on the goal. That simple fact should inspire us all to rise above our differences and get to work.

It is our strong recommendation that ‘executive assertion’ can be a solid start of this process. The simple statement that “this is the direction we are going” goes a long way toward providing institutional focus for the organization. We also believe many actions that have little or no cost can be started immediately.

One example might be an assessment of the current engineering alumni outreach effort. How is this organized? How many people are involved? What is the budget? Is there a focused mission statement with specific objectives? Who has responsibility for the overall effort? How and when do we assess the effort? What constitutes success? Many other such efforts tied to the recommendations in this report can be quickly started as well.

The aggressive nature of our recommendations with respect to pace and performance also suggest that a review of administrative skill sets be conducted for positions responsible for accomplishing key tasks. We know from experience that exceptional performance in one part of the organization does not always translate into good performance in another. Much will be riding on solid operational performance so we should give ourselves the best chance to succeed.

In a perfect world, we see the day the new engineering building is opened as the dawning of a new era. We believe this event ought to be preceded by the establishment and many months of smooth operation of a number of the recommended programmatic initiatives. For example, we see no reason that an alumni outreach program could not be well underway.

Likewise, a high performance internship program should be functional as well. Graduate niches should be into their second or third year, and a targeted list of desirable faculty to support these niches developed. The company partnership effort should be in its third year as well.

We also believe despite the enormity of the challenge, Wyoming is in an extraordinary position. Few if any states can claim the unity of vision found in Wyoming.

We recognize this report recommends a departure from the traditional funding cycle for building construction at the University of Wyoming.

Traditionally, it has been as follows: Ask for money, design and build what the University system believes appropriate, report back to the Governor and the Legislature. We are suggesting a much more program-driven approach with active, involved roles for the UW President, the Governor and the Legislature.

As we stated above, this is an exciting time for engineering, science, technology and mathematics at UW. We stand ready to assist in the realization of this opportunity.



7) WORK TO BE COMPLETED:

The review of this draft report has yielded a list of tasks to be completed. The majority of these tasks fall to the University and are scheduled to be completed by February 18th. The Task Force will take responsibility for the task labeled “Legislative Leadership”. The tasks listed below are in no particular order.

- ✓ **Timelines:** We believe timelines and milestones should be created for the recommendations listed above. As the operational manager of the effort, the University is in the best position to attach timelines and milestones to each of the recommendations. It has been recommended that these timelines cover short-term, medium-term and long-term horizons for each recommendation.
- ✓ **Assignment of accountability and responsibility:** Again, as the operational manager the University is in the best position to assign responsibility and accountability to specific managers for completion of the recommended tasks.
- ✓ **Niches:** The University will describe its selected niches in 3 to 5 areas it judges appropriate to this effort.
- ✓ **Metrics:** The Task Force recommends establishing ‘where we are today’ relative to other Tier 1 engineering colleges. As we understand it there are numerous quantitative measures available in academia. As President Buchanan explained, some are worthy and credible while others are not. We have asked the University to present the well-accepted, credible metrics that other Tier 1 universities would use for comparison purposes.

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- ✓ **Integration:** Throughout the report we have referred to “integration”. We are interested in a thorough discussion of this idea relative to collaboration across traditional academic departments, facility sharing, destruction of nonproductive “silos” and other functions. Our understanding is University leadership spends significant time and energy on these topics. We look forward to increasing our knowledge about how this is being approached at the College of Engineering.
- ✓ **“No penalty for failure, no reward for excellence”:** This is our catchphrase for addressing the motivation for becoming Tier 1. We want to understand where the pressure, drive and initiative to reach Tier 1 are coming from inside the University. Particularly, we are interested in how this drive might be reinforced by external groups including the Task Force.
- ✓ **University Plan 4:** It has been suggested that the recommendations contained in this report be integrated into University Plan 4. We agree and look forward to how that can be done.
- ✓ **“Out of the box” thinking-creative ways of thinking (combining departments, creating efficiencies, maximizing educational impact):** We believe our understanding of what might be taking place at UW could be greatly enhanced with a presentation of specific examples of creative approaches currently under way.
- ✓ **Legislative Leadership:** The Task Force will take responsibility for engaging Legislative Leadership in the discussion of the recommendations contained in this report. We are particularly interested in the conversation around focus and priorities implied in aspiring to Tier 1 status. We plan to have this task completed by February 18 as well.



No penalty for failure, no reward for excellence: This is our catchphrase for addressing the motivation for becoming Tier I.

LEGISLATIVE CHARGE

Legislative Charge to the Joint Minerals Committee, '12 Laws, Chapter 27, Section 1(e)

(e) The joint minerals, business and economic development interim committee, in consultation with the governor, the college of engineering, the school of energy resources at the University of Wyoming and the community college commission, shall:

(i) Assist in the development of the parameters for the renovation and reconstruction plan for the college of engineering at the University of Wyoming, which plan shall be designed in cost and approach to lead the university toward a tier one academic and research institution in areas of excellence appropriate for Wyoming. It is anticipated that the budget for the project will approximate one hundred million dollars (\$100,000,000.00) or so much as is reasonably needed to accomplish this task;

(ii) Develop a plan for the use of an appropriate amount of anticipated remaining abandoned mine land funds to fund programs that support and enhance new and existing technologies important to the economy of Wyoming. The programs may include grants and equipment purchases that will recruit and retain innovative research and technological advances with a goal to create sustainable jobs and economic development along with improving the prestige and quality of teaching at the college of engineering and community colleges.

POTENTIAL NICHE: CENTER OF INNOVATION FOR FLOW IN POROUS MEDIA EXECUTIVE SUMMARY

The State of Wyoming has invested approximately \$300M in developing energy programs at its only university over the last eight years. The results of this investment have created a platform for developing world-leading capability in key technology areas that will lead to breakthroughs in fundamental knowledge that is critical for optimal production of fossil energy resources.

To this end, the University of Wyoming (UW) seeks to establish a Center of Innovation for Flow in Porous Media in Laramie, Wyoming. The mission of this Center will be to significantly advance the state-of-the-art knowledge of multiphase flow and transport in porous media. This is pivotal to extracting maximum value from both conventional and unconventional reservoirs, and will be achieved through collaboration with the world's leading research scientists in an unrivalled experimental research facility. We propose to partner with Private Sector Sponsor(s), organizations that have both the strategic interest and the capability to provide financial and technical support for this initiative.

Under this truly unique enterprise, groundbreaking technologies will be developed and deployed in stages to establish the world's most advanced porous media flow innovation center. The blueprint for this core of experimental research, development, and innovation is based on the following key components:

- Facilities and equipment specifically designed to enable world-class experimental and computational research.
- Workforce with multidisciplinary expertise to address critical subsurface challenges.
- Broad partnerships to conduct and sustain cutting-edge research.
- Funding sufficient to build, equip, and operate the Center for a decade.

The Center will provide a broad range of benefits to the body of knowledge, our Private Sector Sponsor(s), partnering institutions, enablers, State of Wyoming, and UW. Chief among the benefits will be a greatly advanced understanding of the fundamentals of multiphase flow and transport across the full range of scales pertinent to oil and gas reservoirs — especially unconventional reservoirs — that will ultimately result in maximized resource recovery. The private sector sponsor(s) should expect bottom-line financial impact commensurate with the size of investment we seek to establish this center.

The Center will be designed and implemented with an aggressive schedule in three stages. We believe Stage I can be fully operational in 1-to-2 years from the time funding is secured.

Key elements of this initiative include:

- Academia-Private Sector Sponsors: Full partnership between UW and private sector sponsor(s) is a critical component of the Center's establishment and long-term mission. Such a partnership will provide funding, context, and real-world challenges to guide our studies.

- *Institution-Institution*: The Center will form a virtual network of key academic institutions from around the world that share the same strategic goals. Scientists and graduate students from these in network institutions will be able to spend extended periods of time in the Center to collaborate. Furthermore, outstanding investigators/experts from out-of-network institutions will also be welcomed to work in the Center under appropriate arrangements.
- *Enablers*: The Center will build robust collaboration with two key groups of enablers: i) instrument design and manufacturing companies; and ii) service companies. Representatives from these companies will be consistently present at the Center, participating in different research projects being executed. They will interact with visiting scientists and students on the use and development of technologies, hence devising ideas for the next generation of instruments, as well as deployment of these technologies.
- *Funding*: We aim to develop a close partnership with private sector sponsor(s), organizations that have both the strategic interest and the capability to provide financial and technical support for this initiative.
- *Staged Development*: Development will occur in three stages over several years as follows:

Stage I – Establishment (Years 1-2) – Operation (Years 1-6):

In this stage the Center will focus on the acquisition of research instrumentation and establishment of laboratories for high-pressure and high-temperature multiphase flow and transport in porous media at multiple scales:

- Six replicates of Macro-Scale Reservoir-Conditions (RC) Three-phase Flow and Computed Tomography (CT) Laboratory (Imaging resolution per slice: 250 μm)
- Three replicates of Micro-Scale RC Three-phase Flow and Micro-CT Laboratory (Imaging resolution: 0.7 μm)
- Two replicates of Nanometer Resolution Imaging Laboratory (Imaging resolution: 2 nm)
- One Environmental Transmission Electron Microscope (ETEM) for performing chemical research at the atomic level

Stage II – Growth (Years 4-5) – Operation (Years 4-10):

In this stage we will expand the experimental capacity of the Center through development of additional flow and transport laboratories at the above-mentioned scales and establishment of new facilities:

- Four replicates of Macro-Scale RC Three-phase Flow and CT Laboratory
- Two replicates of Micro-Scale RC Three-phase Flow and Micro-CT Laboratory
- One Nanometer Resolution Imaging Laboratory
- Two replicates of Macro-Scale Rock Mechanics Laboratory
- Two replicates of Micro-Scale Rock Mechanics Laboratory

It should be noted that the above list (under Stage II) can be modified to reflect the needs of the Center and our private sector sponsor(s) as well as the advent of new technologies.

Stage III – Commercialization (Years 7-10):

Under this stage we will:

- Transition a portion of the experimental research capacity to perform service work to provide the Center with a means for Intellectual Property (IP) deployment and additional revenues for research and development.
- Deploy new advanced technologies and instruments if deemed appropriate by leadership as they become available. This will include other forms of experimental research that the Center may consider pivotal for its mission.

APPENDIX C

TABLE: SUMMARY OF FACILITY USE.
 (Circle shading reflects approximate extent of facility use for the indicated activity; i.e., heavy, medium, or light use)

ACTIVITY	FACILITY				
	NWSC	EIC	STEM	EERF	EB
Engineering Education					
Undergraduate					
Graduate					
Engineering Research					
Undergraduate					
Graduate					
Faculty					
Use by Multiple UW Units (Teaching or interdisciplinary activity)					
Use by Industry (Mainly for applied research and service)					
Use for Outreach (General connectivity with community colleges, schools, and employers)					
Notes					
NWSC = NCAR-Wyoming supercomputer (completed)					
EIC = Energy Innovation Center (SER facility, nearly completed)					
STEM = ENZI Science, Technology, Engineering, and Mathematics Labs (in construction)					
EERF = Energy Engineering Research Facility (planned)					
EB = Engineering Building (expansion planned)					





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