Governor's Task Force on K-12 Science, Technology, Engineering and Math Education (STEM)

September 25, 2014

Manchester Community College, Manchester, NH

Task Force Members in Attendance:	Ross Gittell, Chairman; Brian Blake; Barbara Couch (by phone); Joyce Craig; Susan D'Agostino; Mary Kate Hartwell (by phone); Joseph Helble; Robert Hallowell; Todd Lamarque, Paul Leather and Palligarnai Vasudevan
Unable to Attend:	Caroline Herold, Jeremy Hitchcock; and Dean Kamen
Others present:	Molly Connors, Governor's representative; Mary Laturnau, Director of School Engagement, Project Lead the Way; and Dr. Mark Wiley, Dr. Mark Wiley, University of New Hampshire and NH STEM Coalition

I. Call to order

Chairman Gittell opened the meeting at 4:00 p.m. by welcoming members of the Task Force and the public who were present at the meeting.

II. Approval of September 16, 2014 minutes

Robert Hallowell made a motion to accept the minutes. Dr. Susan D'Agostino seconded. The minutes were approved unanimously.

III. Items requiring discussion

a. Task Force review draft outline for final report to Governor on STEM Education (attached Addendum One). They accepted the final report outline with the following change: remove "resources needed" from individual recommendations and combine into one discussion under the heading "Next Steps."

b. Review draft summary of the following recommendations (Addendum Two)
- Group 1: STEM-Inspirations –challenges, competitions and capstones
- Group 3: STEM Teacher Support Network
- Group 4: STEM Every Day in Different Ways: Curriculum Integration
- Group 8: Next Generation Science Standards

GROUP 1: STEM Inspirations

- Make the three STEM study opportunities more explicit: reword to clarify that STEM INSPIRATIONS is envisioned as a series of three opportunities throughout the K-12 careers of students beginning with thematic projects, moving to team-based competitions and culminating with capstone projects. Additionally, studies designated as STEM (whether science, technology,

engineering and/or math) should be clearly aligned so grade-level performance in science, for example, utilizes grade-appropriate use of math.

- Rather than specify detailed implementation, TF Districts or SAUs be asked to prepare a local plan to achieve the STEM Inspirations goal of three types of learning: thematic projects, competitions and capstones.
- Baseline studies: TF suggested removing language about yearly performance assessments. Describe Next Generation Science Standards as guidelines to scientific reasoning, especially critical thinking and achievement of 21 Century learning skills.
- Advanced studies: What should a capstone project encompass? Should be flexible –inclusion of all STEM topics or concentration in one, drawing upon the other STEM subjects as appropriate. Enable districts/schools to determine their own approach to capstone projects. Examples may be included in the recommendations to help with clarification.
- Additional: Edit language regarding the preference of girls for certain types of STEM studies; revise to broaden areas for exploration. Will continue to work on this area of the recommendation.
- Given the variety of local districts in NH, Districts/SAUs s might be asked to prepare implementation plans for STEM Inspirations using general guidelines at the State level.

GROUP 3: STEM Support Network:

- This becomes a "meta-theme" to unify the recommendations, and will not remain as a separate recommendation. STEM Support Network will be moved into a Final Report as part of the explanation of an overall implementation plan.
- Teacher professional development centers will be combined with Innovation hubs (described in Group 4) and will be reformulated into a new recommendation for Innovation and Teacher Support Hubs (working title)

GROUP 4: Curriculum Integration.

- Teacher Professional Development will be transferred and incorporated into Group 6 (Teacher Preparation and Professional Development)
- Innovation Hubs will be transferred to a separate recommendation and will incorporate, as noted above, the Teacher Professional Development hubs.

GROUP 8: Next Generation Science Standards.

- Define NGSS as performance expectations (indicators) that will enable students to achieve 21st century learning skills (analyze, argue, construct and develop scientific arguments). Perhaps provide guidance to districts on what criteria is needed to achieve grade-level achievement.

c. Brief discussion of definitions for STEM, STEM education and careers

Dr. D'Agostino briefly reviewed a draft of proposed definitions for STEM which will be circulated to the Task Force and discussed at the next meeting. She noted that definitions vary widely throughout the US and internationally, with little agreement. She urged the Task Force to consider adopting a succinct definition that will be useful to both STEM professionals and the public.

d. Review "parking lot" ideas and determine next steps.

Task Force reviewed, in brief, the parking lot ideas and asked that they be addressed at the next meeting.

IV. Public input:

Mary Laturnau briefly explained the purpose of Project Lead the Way and distributed information; Mark Wiley suggested that the Task Force consider the motivational factor for each group that is asked to help with STEM adoption.

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ADDENDUM ONE

Outline for Final Report to the Governor (9.25.14)

I. Executive Summary (1-2pp)

This summary will include the meta-theme(s) that will organize the big ideas contained in recommendations, the list of recommendations, and appropriate infographic representation. *Note: the executive summary will be the most widely read portion of the report so we will strive to make it concise, clear and informative.*

II. Introduction (1 -2 pp)

- Setting the Stage: Why STEM and why STEM now? The case for economic and education to workforce realignment
- Governor's Executive Order, the charge to the committee, etc.
- Explain what is to follow – provide visuals? Call outs?

III. STEM Education: NH Context (2 pp)

- Defining STEM, STEM education and STEM careers (we have noted that there is no consensus nationally on what these terms mean and therefore we need to clarify for our readers).
- NH STEM: Needs and vision for the future
- 21st Century Learning skills (define and link to STEM) 9.25.14 added

IV. Recommendations in Detail

- Each recommendation described – uniform format 2 pages each)

V. Next Steps

- Resources needed (address resources needed for recommendations, rather than in each recommendation). Added at the 9.25.14 meting
- Do we add in implementation?
- Commitments and actions required (2 pages)
    - For Educational leaders in NH (added at the 9.25.14 meeting–specify who we mean)
    - For Policymakers in NH
    - For Business and Industry Leaders in NH

VI. Conclusion (1 Page)

- If applicable, perhaps put in a summary grid of recommendations to recap report

VII. Endnotes

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VIII. Appendices

- Task Force members
- Task Force: How it was organized and executed (subcommittees, etc.)
- Resource readers

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ADDENDUM TWO

STEM-INSPIRATION: GROUP 1

Building Student Interest in STEM through Challenges, Competitions, and Capstones

Joseph Helble, Brian Blake, Joyce Craig, Dean Kamen

Problem Statement

Studies show that students gradually disengage from science and math in the later years of elementary school. Their natural curiosity about the world is replaced by a perception that science is difficult, or is only for a certain type of student. A major challenge in developing a STEM-literate population and skilled workforce therefore lies in maintaining excitement through the critical middle and high school years, to keep students engaged in learning. Students need to understand that science and math provide a foundation for understanding the world, and be inspired to apply that understanding to invent solutions to some of the world's most challenging problems through engineering and the development of technology.

Recommendation

Applied STEM learning opportunities, including competitions and capstone projects, should be expanded, and incorporated into school curricula at several levels, using FIRST as a base and model program. At a minimum, age-appropriate STEM-INSPIRATION sequencing should begin with thematic, project -based STEM topics or "challenges" in early grades, then move to collaborative, team-based district-wide or regional STEM competitions in middle school, and finally to a capstone project which requires independent problem-based project research, and presentation of results for peer and evaluator review in high school. NGSS (adopted by many districts in NH) is closely aligned and integrated into this work.

Recommendation Details

Baseline:

- Utilizing the NGSS as a foundation piece, each school will design and implement[1] a sequence of performance assessments at each grade level beginning at grade 4.
- Utilizing the NGSS as a foundation piece, each school will develop a thematic, project-based exploration of a relevant STEM topic in elementary school, ideally in 4th grade. This "challenge" would be a broad theme or question around which a teacher can provide context and insight, students can read and discuss stories on the topic and an age-appropriate in-class or at-home project would be developed.

[1] Yellow highlight indicates that Group requests discussion with the Task Force to determine the appropriate descriptors

- Competition: To provide opportunity for deeper learning, each middle school will field at least one team participating in an organized STEM-related competition. FIRST Lego League and FIRST Tech Challenge are NNH-based examples of such competitions.
- Utilizing the NGSS as a foundation piece, each high school will design a "Capstone" project that will require each student to conduct independent problem-based project research in a STEM area, and present the results for peer and evaluator review. It is strongly recommended that such capstone projects go beyond paper studies to incorporate a laboratory, computational, field-study, or engineering design component.
- (Each school will?) Incorporate specific technology/engineering based activities and performance assessments at each grade level, in alignment with the NGSS.

Advanced:

- For deeper engagement with STEM content, methodologies, and opportunities, schools may wish to build beyond this foundational level. For these schools, the following are recommended: A capstone project will be included in the final year of middle school for each student. Participation in a team-based, district-wide or regional STEM competition such as FIRST Robotics will be supported at the high school level.

Target Audience and Measures of Success

The goal of this recommendation is to build a process for students to become STEM literate at different levels, from "aware and conversant" and able to adapt to changing technology in the workplace, regardless of chosen career, to highly trained scientists and engineers leading the discoveries and inventing the technologies of tomorrow.

Once fully implemented, the targeted levels of participation at the baseline level are as follows:

- 100% of NH elementary school students will participate in a thematic STEM challenge.
- 100% of NH middle schools will participate in a STEM competition such as FIRST Lego League or FIRST Tech Challenge.
- 100% of NH graduating high school seniors will complete a STEM-focused capstone project.

Implementation Plan: Necessary Steps and Resources

School districts will need curricular support for elementary teachers to develop examples of STEM-based challenges. Funding will be needed to help support middle school participation in STEM-based competitions such as FIRST Local volunteer coaches will be needed to help support middle school participation in STEM-based competitions such as FIRST. A committee of high school science and math teachers and other parties as appropriate will need to develop curricular guidelines for high school STEM capstone projects

Additional

Girls remain significantly underrepresented in many STEM fields. This is particularly true of engineering, where fewer than 20% of bachelor's degrees are awarded to women, a number that has changed little in decades. In some branches of engineering however, particularly those related to the life sciences, the percentage of women is much greater and in some areas approaches gender parity.

Competitions such as those sponsored by FIRST excite and inspire young students to experience and explore STEM and develop their creative talents. FIRST explores broad themes and is collaborative and team-based, but the underlying elements of mechanics, robotics, and coding do not appeal to girls at the same level as those related to the life sciences. The challenge is to develop a comparable "collaborative competition" for students in grades 6-8 or 9-12 that draws directly from the life sciences, medicine, and related fields.

Benchmarks

Identify states with highest percentage of schools or school districts participating in FIRST or other STEM-based competitions. Using this as a goal, set timeline for NH to attain a position of national leadership.

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ADDENDUM TWO

STEM SUPPORT NETWORK: GROUP 3:

Merged recommendations: Team A3: STEPS and Team B3: TEACHERS STEM SUPPORT CENTERS

Challenge #1: Building Support and Educating Stakeholders (students, parents, policymakers, educators) about the value of STEM

Without the support of key stakeholders and an appreciation for the power of STEM studies in K-12, and especially in elementary and middle school, New Hampshire risks not building the public support needed to implement a STEM turnaround – to fill the promising careers available at all levels in STEM. Using the New Hampshire "way" which is to build grass-root support for efforts, the following idea is recommended.

THE IDEA/IMPLEMENATION

PUBLIC OUTREACH AND EDUCATION

- **STEM Leadership Ambassadors (STEM Diplomats)**: Loan of business and academic leaders in STEM fields for a period of one-year to be known as the "STEM Ambassadors" to act as liaisons on STEM to parental groups such as PTOs, to professional organizations such as NH Teachers of Mathematics, Business and Industry Council, district school boards, charter school boards and to Education, testify and meet with appropriate committees in the NH House and Senate.

Challenge #2: Support for STEM Professional Development

Elementary school teachers, especially K-6 are prepared and certified in general education often lack requisite preparation math and sciences necessary to teach with an integrated STEM curriculum; most teachers in 7-12 have not been trained to teach an integrated approach to science, technology, engineering and math.

THE IDEA/IMPLEMENATION

TEACHER PROFESSIONAL DEVELOPMENT **(recommend moving to Group 6)**

- **STEM Regional Innovation and professional development hubs**: serve as physical location for STEM activities including virtual and in –person courses, seminars, discussion groups, etc. Also serve as science centers and/or labs (modeled on Fablabs, Makerspace, etc.) for teachers and students to work together (such as the UNH Discovery Lab model). These hubs could include in-district or cross-district field trips.

Would also provide a "lending library" for STEM curriculum materials not available in local schools or districts.

Note: There are a number of facilities that might be adapted for this use including: (1) the network of LECSN (Local Education Center Support Network), a series of five centers throughout NH that provide teacher professional development and technology support. These centers are equipped with up-to-date video conferencing, so could support a variety of activities; (2) Science museums as a Montshire (Upper Valley); The McAuliffe-Shepard Discovery Center; The UNH Discovery Lab, and others.

- **STEM speakers from science/business and industry**: Regular virtual and in-person seminars and discussion groups with STEM leaders in innovation, scientific research and academia (for award of CEUs and/or micro-credentials such as certificates or badges). **Action Needed:** Commitment by at least 10 companies in each school district – starting with model pilots in at least 5 districts, one in each of the five regions of NH.

- **STEM district/school specialists/teacher-**leaders. Teachers who have a background in one of the STEM fields and have received additional training to teach STEM as an integrated subject. **Action needed**: Start with 5 pilot districts, modeling the framework on the schools that are already using STEM specialists. Legislative funding would be required to support this; otherwise it will be an unfunded mandate and will not be implemented.

- **STEM externship opportunities for K**-8 Teachers (To address problem of no "real-world experience" for curriculum design). **Action Needed**: commitment from business/industry and science labs to provide these externships. Call it the "Leadership 100 programs –which promise of 100 externships by end of 2015.

- **STEM /NGSS Coordinator**:
  The Coordinator would be responsible for organizing and ensuring success of these programs and would most likely be located in the Department of Education to ensure continuity with other related programs in D-12. **Action Needed:** authorization and funding for Department of Education to hire a full time STEM/NGSS coordinator.
  Some ideas for the NH STEM coordinator responsibilities include:
  - Organize Speakers and Ambassadors
  - Work with districts and schools for STEM leaders/specialists in districts or schools (this was suggested elsewhere)
  - Teacher professional development activities
  - ensure Innovation Hubs are functioning as envisioned -perhaps start with pilot
  - oversee issues with STEM packs (curriculum suggested by Group 6)

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ADDENDUM TWO

STEM INTEGRATION: GROUP 4:

<u>Look, touch and feel STEM Every Day: Curriculum Integration in the Classroom</u>:

Robert Hallowell, Ross Gittell, Joseph Helble, and Todd Lamarque

"Science and math are about understanding and interpreting, while Technology and Engineering are about invention, creation, and the development of solutions to challenging real-world problems".

K-8 students should be taught the basic concepts of math and science but also exposed to hands-on learning of those base skills as they apply to technology, engineering and the wide breadth of STEM topic areas.

Merged Problem Statement:

In-school opportunities for STEM related learning is insufficient, particularly in K-8, for a variety of reasons: (1) science time has been eliminated or reduced to focus on core subjects of reading, writing and math (2) even when science is included it does not encompass the application of math and science for technology and engineering (3) without science, technology and engineering students have little opportunity to apply their math skills (4) teachers lack the training and experience to create and deliver in an engaging way STEM instruction and hands-on learning (5) students are left with little opportunity to explore STEM topics that might interest them and create a passion for learning. The TF recognizes that a strong foundation in math and science is necessary but not sufficient for students to excel in Technology and Engineering. Our recommendation here is meant to "elevate our game" in STEM across the state, and not simply check off the science box as STEM.

RECOMMENDATION:

Support the "day to day" application of science and math in K-8 education with hands-on learning of those base skills as they apply to technology, engineering and the wide breadth of STEM topic areas. Goal should be applied STEM every day in different ways for young NH learners. Technology and engineering are the "TiE" that makes STEM relevant and exciting particularly for students who learn by doing and experiencing rather than by reading and memorization. This recommendation attempts to address three key barriers to STEM education -- the tightly packed K-8 schedule, the shortage of quality applied STEM resources, and the lack of current and applied science expertise among teachers in K-8 grades.

??This recommendation seeks to help teachers to integrate STEM topics and practices into current math and English language arts requirements. It also is meant to aid STEM teaching professional development with a "STEM master" teacher/mentor in each school or district who can help to organize STEM applied activities.

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DETAILS

There are three core areas we are recommending improvement to extend the state's reach to the core of STEM – Technology and Engineering. These areas are (a) physical resources, (b)external subject matter experts and (c) teacher PD and curriculum resources and.

Physical Resources:

Creating space and opportunity for exploration is critical for engaging students in building, innovating and experimenting. The task force recommends the following infrastructure improvements be implemented by the state:

STEM Labs/ "Maker-spaces":

The state should support the creation of STEM labs in not only middle school but also elementary. A STEM lab differs from a science lab in that there are areas of the lab where students are allowed to explore and build on their own. A bin of LEGO robotics, or electronics that can be dismantled and reassembled might be appropriate at the middle level. While at the elementary level simpler materials for building (blocks, Legos, weather experiments, etc.) would also work. There are many examples of such spaces being built and utilized across the country, a set of components would be defined by the state and local districts could pick and choose the components they would like to use. The state would subsidize a portion or all of the expenses for the equipment for the SAU.

Most middle schools have existing science labs that could be converted to STEM labs. At the elementary level, some schools would have space to create a STEM lab while others might be able to convert a portion of their library space into a STEM lab. Alternatively, elementary schools could consider placing a STEM specialist in the rotation of other elementary specialists (art, music, etc.).

Pre-packaged STEM packs:

STEM packs contain a single experiment and a unit of instruction as a guide for the teacher. For example the pack might contain the parts to make a weather station that the student must learn to assemble. The unit of instruction would show the teacher how the weather instrument works and how to show students what they might do with it.

Mobile STEMperiences:

The state would maintain a fleet of mobile labs for school districts to bring in as a special STEM experience. Some examples might be: a blow-up planetarium, a large telescope, small radar, a solar array, a wind turbine, etc. Local districts could use these for specific classes or as part of a community experience (for example an

"astronomy" night where community members bring their own telescopes in addition to the large telescope or planetarium).

External Subject Matter Experts:

STEM Explorers:

Create a STEM EXplorers bureau (STEM-EX) where STEM professionals in industry and at colleges and universities in NH would make themselves available as resources for project based learning, in class presentations/demonstrations and/or "site visits" to local schools. Explorers would have to commit to registering with their areas of expertise and contact information and to being available at least twice during the school year.

The Explorers would be recruited with a variety of backgrounds and from a variety of STEM fields in SAUs across the state. The Governor would put out a call for volunteers and higher education institutions (including the CCSNH, USNH, SNHU and other NH based colleges) and industry groups (including the High Technology Council, NH Business and Education Coalition and the NH Business and Industry Association would recruit Explorers. One of the educational institutions (e.g., UNH Education Department) would take the lead with recruiting, screening registering, training and organizing the Explorers with support from a state or Foundation grant.

An online "directory" of NH STEM Explorers would be created. It would have information and key word/capability search capabilities on location, subject matter expertise, grade level preference, and activities of interest among the fields of information available for each Explorer. There would also be capabilities for feedback and recommendations from teachers and students to Explorers and from Explorers to teachers. And there would be summary ratings/comments available as reference for other Explorers and Teachers to access.

At the end of each academic year Explorers who have successfully assisted STEM education in NH would receive formal recognition from the local SAU and Governor and also be eligible for annual award of STEM Explorer of the Year.

STEM stops:

As above, create a resource database of businesses or higher education institutions that would provide field trips and learning experiences for students. The Governor would put out a call to NH Businesses and higher education to create such opportunities. Prospective businesses/colleges would identify the STEM focus of their activities and the age level of the experience. As with the STEM-EX, businesses who provided opportunities to students would be recognized for their efforts and be eligible for an annual explorer award.

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Teacher PD and Curriculum Resources:

Teacher Professional Development

Provide a NH STEM endorsement/certification program through the State of New Hampshire. The two pathways would be a series of (5) college-level courses offered through a state approved college and/or university. Or (45) hours of NH STEM approved activities.

Create a series of NH STEM activities for professional development. These are activities that are a cross-section of science, technology, engineering, and mathematics presented in an inquiry-based format. They would be based on the Next Generation Science Standards (NGSS) for grade level science and engineering content, the NH Technology standards for grade level standards in technology, and the Common Core State Standards (CCSS) in mathematics for grade level math standards. They include:

- Provide opportunities for teachers to have externships in order to learn from people in STEM fields (such as Project Lead the Way, EBD, NHEET, etc.)
- STEM partnerships/internships/camps for teachers (summer, school vacation, etc.)
- STEM professional development opportunities for school administrators and school board members on bi-annual basis.
- Develop assessments to measure and support STEM teaching.

Curriculum

- Support established STEM programs such as Project Lead The Way (gateway, Launch, etc.) for grades K-12.
- Develop curriculum that uses the NGSS, CCSS, and the NH Technology Standards to create district/school units to create STEM curriculum/activities K-12, if districts/schools do not want to purchase a complete program.
- Develop three (3) sample units/lessons will be developed for grades K-6 for those districts without a program such as PLTW.
- Recommend hours/week for STEM teaching and exploration for grades K-4, 5-8, 9-12
- Support the addition of a STEM specialist for districts/schools.

Benchmarks:

There are obvious benchmarks such as NECAP science scores, and SBA math scores. But are there leading indicators?

- The number of schools with transformed STEM labs
- The number of students who opt for science or other STEM electives in high school

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ADDENDUM TWOTASK FORCE ON STEM EDUCATION: GROUP 8

Next Generation Science Standards integrating E & T

TOPIC	DESCRIPTION FRAMEWORK
Problem statement *What problem are you addressing?*	The current Science Standards for NH were adopted in 2006. They do not address 21st Century Skills. They focus on recalling facts and do not lend themselves to discovery and a deeper depth of knowledge.
What Target Audience do you seek to reach? *Grades K-2? 3-5? 6-7-8? 9-12 (or any variation you feel appropriate)*	K-12 students enrolled in public schools
% of target audience you will reach? 25% 50% 75% 100%	100%
What are your desired goals or outcomes? *Describe how the outcomes or goals will positively impact the problem addressed*	The NGSS incorporates practices, cross cutting concepts and key ideas including Science, Math and Language Arts. The Standards are written as performance expectations which require students to analyze, argue, construct, design, and develop (all 21st century skills).

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What is your recommendation/s (big idea/s) *Describe the recommendation.* *How does this recommendation achieve outcomes/goals to meet the needs of your target audience?*	Adoption of the Next Generation Science Standards (NGSS) to replace the current standards that were adopted in 2006. By adopting the NGSS, students across the State will be exposed to and develop deeper learning and critical 21st century skills, leading to higher achievement.
What constitutes "success" for this idea if implemented?	Implementation of NGSS and higher science achievement.
Implementation plan (model): if this idea is implemented, what is needed to make it successful? *Who are the actors * and what do they need to do (obligations of each)?*	• Designate a Leadership Team at the State level to lead the implementation. • Review the State's capacity for adoption and implementation • Create a concise timeline for adoption. • Create STEM and NGSS Coordinator at State level • Develop a vision for how the NGSS will affect students in NH. • Determine what the financial requirements will be for implementation.
Challenges to overcome?	Public sentiment against national standards.
Resources needed?	None at this time.
Timeline?	2 years
Examples of best practices/similar approaches in current practice in NH or elsewhere?	Other New England states have adopted the NGSS and we would work with them toward implementation.