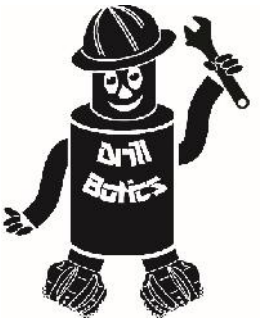


Society of Petroleum Engineers
Drilling Systems Automation
Technical Section (DSATS)

Drillbotics™

International University Competition

2015-2016

1. Introduction

The Drilling Systems Automation Technical Section (DSATS) was established in 2008 to help accelerate the uptake of automation in the drilling industry. The goal is to link the surface machines with downhole machines, tools and measurements in drilling systems automation (DSA), thereby improving drilling safety and efficiency. The technical section believes that we can encourage new entrants into the drilling industry to consider creating and using automation tools and techniques in future drilling programs. One way to attract these entrants is to provide a challenging project to students who plan to become petroleum engineers and to other students in related disciplines who may not currently think of the upstream drilling industry as a career opportunity. DSATS hopes that an international competition among the various universities who have a drilling curriculum would catch the students' interest and that the participants could create or adapt new technology in a way that could benefit the drilling industry. The winning team will be provided funding to travel to the next SPE Annual Technical Conference and Exhibition (ATCE) to present a technical paper about their solution and their work.

Version	Date	Section	Description
2016.01	2 Jun 2015	All	Rewrite 2015 Guidelines

2. Objectives for the 2016 Competition

2.1. During the school year beginning in the fall of 2015, a team of students will organize themselves to solve a drilling related problem outlined in item 4.1 below. The team should preferably be a multi-disciplinary team that will bring unique skills to the group to allow them to design and construct hardware and software to demonstrate that they understand the underlying physics, the drilling issues and usual means to mitigate the issues.

2.2. The students could produce novel ideas leading to new drilling models, improved drilling machines and sensors, and the ability to integrate the data, models and machines that will hopefully create new, more efficient ways to drill wells in the future.

2.3. The students, working as a multi-disciplinary team, will gain hands-on experience that will be directly applicable to a career in the upstream drilling industry.

3. Background

What is DSATS?

DSATS is a technical section of the Society of Petroleum Engineers (SPE) organized to promote the adoption of automation techniques using surface and downhole machines and instrumentation to improve the safety and efficiency of the drilling process. More information is available on the DSATS web page at DSATS homepage (http://connect.spe.org/DSATS/Home/) which will include official updates to the competition guidelines and schedule.

Why an international competition?

DSATS, as part of the SPE, is a group of volunteers from many nations, connected by their belief that drilling automation will have a long term, positive influence on the drilling industry. This diversity helped to shape the direction of the organization. The group feels that the industry needs to attract young professionals from all cultures and disciplines to advance drilling practices in all areas of the world. The winners of the competition will receive a grant for economy class transportation and accommodations to attend the next SPE Annual Technical Conference and Exhibition and will present an SPE paper that will be added to the SPE archives of One Petro[1]. Additional teams may have an opportunity to present their work at the DSATS automation symposium preceding the conference, and may receive a grant for economy class transportation and accommodations. DSATS believes recognition at one of the industry's leading technical conferences will help encourage

[1] Publication is subject to the ATCE program committee's acceptance of the abstract/paper.

student participation. In addition, the practical experience with drilling automation systems increases the students' visibility to the companies that are leading automation activities.

4. Competition Guidelines

Problem statement for the 2015-2016 competition: This is a two-phase project.

4.1. Phase I – Design Competition

4.1.1. Design an automated drilling machine in accordance with the rules below.

4.1.2. DSATS envisions a small (perhaps 2 meters high) drilling machine that can physically imitate the functionality of full-scale rig machinery. The machine will be the property of the university and can be used in future research and competitions. Innovative designs are welcome, but they should have a practical application to drilling for oil and gas.

4.1.3. The design must provide an accurate and continuous measurement of Wight-On-Bit (WOB) and other drilling parameters, as well as a digital record across the period of the test.

4.1.4. The proposed design must be outlined in Phase I of the project, but changes are allowed in Phase II, as long as they are reported to the Committee.

4.1.5. Design submittal by students shall include

4.1.5.1. Engineering drawings of the rig design, mechanical and electrical and auxiliary systems, if any

4.1.5.2. Design notes

4.1.5.3. Control system architecture

4.1.5.4. Key features for any models and control software

4.1.5.5. Proposed data handling and display

4.1.5.6. Specification for sensors and instrumentation

4.1.5.7. Cost estimate and funding plan

4.1.5.8. Design summary video outlining the design submittal not to exceed five (5) minutes in length. Videos shall be the property of the university, but DSATS shall have the rights to use the videos on its websites and in its meetings.

4.1.5.9. The drilling machine will use electrical power from the local grid not to exceed 2.5 horsepower. Lower power consumption resulting from energy efficient designs will receive additional consideration.

4.1.6. All design, construction and operation of the project are subject to the terms and conditions of section 13.0.

4.1.7. A committee of DSATS members (the Committee) will review the Phase I designs and select the top five (5) teams who will progress to Phase II of the competition.

4.1.8. DSATS shall also award a certificate of recognition and publication on its website for the most innovative design. The design video will also be shown at the DSATS automation symposium at the ATCE.

4.1.9. DSATS will send a drillstring and bit to the top five teams for use in Phase II. Upon request, these components shall be returned to the Committee following Phase II testing. Components may be reconditioned by the Committee and used in future competitions.

4.1.10. DSATS will not fund any equipment, tools, software or other material, including labor, for the construction of the rig.

4.2. Phase II – Drilling Competition

4.2.1. In the spring term of 2016, qualifying teams will build the rig and use it to drill rock samples provided by DSATS. Drilling a vertical well efficiently though the sample is the primary technical objective of the competition. Drilling performance will be observed and measured by DSATS members invited to attend and witness the final test that will be scheduled late in the school year. The test will occur at the participating university.

4.2.2. Rock Samples

4.2.2.1. DSATS will prepare a set of nearly identical samples (appx. 30 x 30 x 30 cm) that will be shipped to each of the final five university teams for the actual drilling test.

4.2.2.2. This will be a manufactured sample of cement, varying soil samples and perhaps some materials that are not normally encountered during normal drilling, but will imitate unusual downhole conditions encountered in some drilling programs. All simulated formations may not be parallel to each other.

4.2.2.3. The university and/or students will provide rock samples as needed to verify the design and allow students to practice using their machine. Drilling of the samples provided by DSATS prior to Phase II testing is not allowed and could lead to disqualification.

4.2.3.Bits

4.2.3.1. One (1) bit, roller cone or PDC, will be provided by DSATS to be used during the Phase II tests. For 2015-2016 the bit will be:

4.2.3.1.1. PDC micro-bit will be 1.125" in (28.6 mm) diameter, with brazed cutters and two nozzles.

4.2.3.1.2. Cutter backrake is 20 degrees; Cutter diameter is 0.529 inches

4.2.3.1.3. Nozzles are 2.35mm diameter, two each at approximately 180 degrees.

4.2.3.2. Students are encouraged to consider bit wear prior to the final test and its impact on drilling performance during the onsite testing.

4.2.3.3. Student teams may build or buy similar bits to test their design with their own rock samples.

4.2.4.Drillstring

4.2.4.1. The drill string provided by DSATS will be chosen to ensure drilling dysfunctions will be encountered. How these dysfunctions are mitigated is a key objective of the competition. Final details of the construction of this drill string will be furnished very early in the spring of 2016 to all entrants upon request. The timing is intended to prevent physical testing prior the spring term. Preliminary specifications are listed below to assist with the mechanical and electrical design of the rig.

4.2.4.2. The drill pipe specifications for the 2015-2016 competition are subject to change, but should be approximately:

4.2.4.2.1. Round Aluminum Tube 3/8 inch diameter x 36 inches long; 0.016 inch wall or equivalent

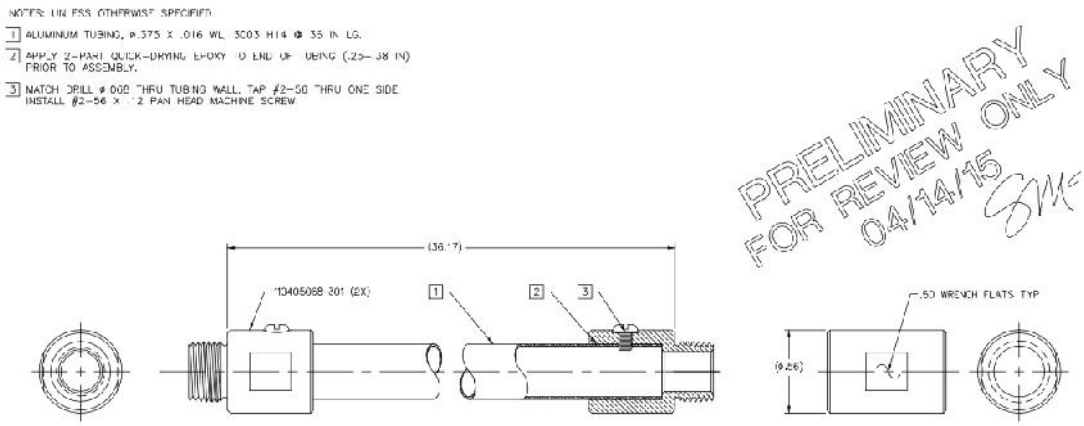
4.2.4.2.2. DSATS will provide the five finalists four (4) joints of pipe. Additional pipe can be purchased by the student teams or university if needed.

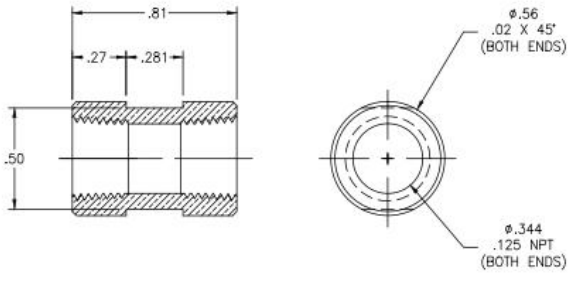
4.2.4.2.3. Available from K-S Hobby and Craft Metal Tubing

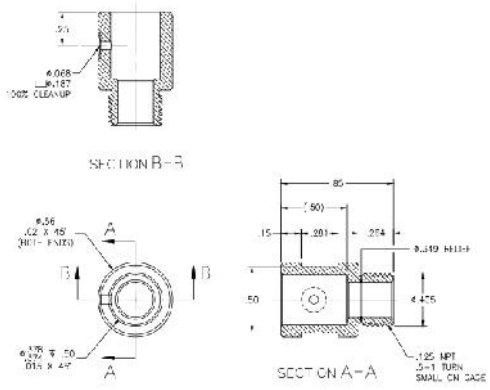
http://www.hobbylinc.com/htm/k+s/k+s9409.htm

ROUND ALUMINUM TUBING		
OUTSIDE DIAMETER INCHES	WALL THICKNESS	ID
3/64 (.047)	.014	.019
1/16 (.0625)	.014	.035
5/64 (.078)	.014	.050
3/32 (.094)	.014	.066
	.016	.062
7/64 (.109)	.014	.081
1/8 (.125)	.014	.097
9/64 (.141)	.014	.113
5/32 (.156)	.014	.128
11/64 (.172)	.014	.144
3/16 (.187)	.014	.159
	.022	.143
	.035	.117
	.049	.089
13/64 (.203)	.014	.175
7/32 (.219)	.014	.191
	.022	.175
	.035	.149
15/64 (.235)	.014	.207
1/4 (.250)	.014	.222
	.016	.218
	.022	.206
	.035	.180
	.049	.152
9/32 (.281)	.014	.253
	.016	.249
5/16 (.312)	.014	.284
	.016	.280
	.035	.242
	.049	.214
11/32 (.344)	.016	.312
3/8 (.375)	.016	.343
	.035	.305
	.049	.277
13/32 (.406)	.016	.374
7/16 (.437)	.016	.405
	.035	.367
15/32 (.468)	.016	.436
1/2 (.500)	.016	.468
	.035	.430
17/32 (.531)	.016	.499
9/16 (.562)	.016	.530
5/8 (.625)	.016	.593

4.2.4.3. Tool joints







4.2.4.3.1. In addition to the drillpipe, DSATS will provide a set of tool joints made from 360 HH brass.

4.2.4.3.2. Students may attached them to the drillpipe using epoxy cement or other material, and/or may use the provided retaining screws if desired. Advise the committee of your choice and why.

4.2.4.4. Bit sub/drill collar

4.2.4.4.1. Upon request, DSATS will provide a bit sub 3/8" NPT box down by ¼" NPT box up by 3"long. However, it is expected that each team will design and build their own bit sub.

4.2.4.4.2. To provide weight on bit and drillpipe tension, additional weight may be added to the bit sub provided by DSATS up to a maximum of 20 lbs / 9.1 kg total.

4.2.4.4.3. The student team will be evaluated on how the weight is designed and how it attaches to the bit sub. Advise the committee of your choice and why and include this in the Phase I design.

4.2.4.4.4. Stabilizers are permitted, but excessive stabilization to stiffen the drillstring to avoid buckling or torsional failure is disallowed. The student team will be evaluated on how the stabilizers are designed and how they attach to the bit sub. Advise the committee of your choice and why and include this in the Phase I design.

4.2.4.5. Students may add sensors to the drillstring, but are not permitted to instrument the rock samples. The sensors cannot appreciably increase the stiffness of the drillstring or add significant weight. Please include concepts only in the Phase I design.

4.2.4.6. The addition of along-string sensors to measure verticality and/or tortuosity will receive extra consideration.

4.3. Automated Drilling

Once drilling of the sample commences, the machine should operate autonomously.

R*emote operation and/or intervention is not allowed.*

4.4. The test well

4.4.1.1. Will be drilled as a vertical well

4.4.1.2. The maximum allowable Weight-On-Bit is 20 lbs / 9.07 kg force.

4.4.1.3. Will not require any closed-loop circulation fluid as part of this year's competition, but the bit and machinery should be cooled with air or fluid/water if needed. Design of the fluid system, if any, should be included in the Phase I design.

4.4.1.4. Drilling with specialized fluids will probably be added in future competitions.

4.4.1.5. Will not intentionally simulate drilling hydraulic hazards such as lost circulation or surge and swab, but this could be added in future years. Note that the rock samples may leak at the junctions between the simulated formations, so a rig design that includes a containment system is strongly suggested.

4.4.1.6. Will not require casing or cement

4.4.1.7. Will not be drilled with a mud motor or turbine.

4.4.1.8. Will not require a rig move, walking or skidding, but the mobility of the rig will be considered in the design phase.

4.5. Not included in the 2015-2016 competition

4.5.1.1. The drilling will not include automating the making or breaking of connections. If this is necessary due to the rig and drillstring design, connections should be made manually, and the time involved with the connections will be added with respect to its effect on drilling performance (rate of penetration reduction).

4.6. Measure and analyze the performance

4.6.1. The drilling machine should react to changing "downhole" conditions to select the optimal drilling parameters for improved performance, as measured by rate of penetration (ROP), mechanical specific energy (MSE), and cost per foot or meter. Consideration should also be given to data handling and data visualization

4.6.2. Design limits of the drilling machine shall be determined and shall be incorporated in the programming of the controls during the construction phase.

4.6.3. The final paper shall outline drilling performance and efficiency criteria and measured results.

4.6.4. Sensors

4.6.4.1. The team may elect to use existing oilfield sensors or may look to other industries for alternate sensors.

4.6.4.2. The team may develop its own sensors if so desired.

4.6.4.3. The final report shall address which sensors were selected and why.

4.6.5. Data collection

4.6.5.1. The team may elect to use standard data collection and recording techniques or may develop their own.

4.6.5.2. The final report shall address which data systems were selected and why.

4.6.6.Data visualization

4.6.6.1. Novel ways of presenting the data and progress of drilling in real time while drilling would receive special attention.

4.7. Two Project Phases

4.7.1. Fall Semester

4.7.1.1. The first phase of the project is to organize a team to design an automatic drilling machine to solve the project problem. It is not necessary to build any equipment in this phase. Design considerations should include current industry practices and the team should evaluate the advantages and shortcomings of today's devices. The design effort may be assisted by university faculty, but the students are encouraged to introduce novel designs for consideration. The level of student, faculty and technical staff involvement shall be reported when submitting the design.

4.7.2. Spring Semester

4.7.2.1. During the second phase, those teams selected by DSATS to proceed to the construction and drilling phase will use the previous semester's design to build a drilling machine. As per industry practices, it is common during construction and initial operations to run into problems that require a re-design. The team may change the design as needed in order to solve the problem.

4.8. Project report

4.8.1.The student team shall submit to DSATS a short monthly project report that is no more than one page in length (additional pages will be ignored) due on or before the last day of each month that will include:

4.8.2. Phase I

4.8.2.1. Key project activities over the past month.

4.8.2.2. Rig design criteria, constraints, tradeoffs, and how key decisions were determine

4.8.2.3. Significant new learning, if any

4.8.3. Phase II

4.8.3.1. Construction issues and resolution

4.8.3.2. Summary of recorded data and key events

4.8.3.3. Drilling parameters [such as WOB] and how they impact the test

4.8.3.4. Other items of interest

4.8.4. In order to teach students that their work involves economic trade-offs, the monthly report should include at a minimum a summary estimate of team member labor hours for each step in the project: design, construction, testing, reporting, and a cost summary for CAPEX, OPEX and other hardware and software related expenditures. Also include labor for non-students that affect the cost of the project. Labor rates are not considered to eliminate international currency effects. Labor is not considered in the cost limits of item 4.7 below, but should be discussed in the report and paper.

4.9. Final report and paper

4.9.1. The five finalists shall prepare a project report that addresses the items in 4.10.6 below.

4.9.2. The winning team shall update the report as needed to comply with SPE ATCE paper submittal guidelines to write a technical paper for publication by the SPE at its Annual Technical Conference and Exhibition. The manuscript is typically due in June.

4.9.3. The report, paper and all communications with DSATS shall be in the English language. The presentation will be made by at least one member of the student team

4.9.4. The timing for submittal of the abstract and paper will be the published deadlines per the call for papers as posted on the SPE's website (www.spe.org).

4.9.5. The abstract must generate sufficient interest with the SPE review committees to warrant publication, although DSATS will help promote acceptance where possible

4.9.6.The paper should address at a minimum

4.9.6.1. The technical and economic considerations for the rig design, including why certain features were chosen and why others were rejected.

4.9.6.2. The setup of the experimental test, the results and shortcomings.

4.9.6.3. Recommendations for improvements to the design and testing procedures.

4.9.6.4. Recommendations for improvements by DSATS of the competition guidelines, scheduling and provided material.

4.9.6.5. Areas of learning gained through the competition not covered in the university course material.

4.9.6.6. A brief bio or CV of the team members and their sponsoring faculty.

5. Team Members

5.1. DSATS envisions that the students would be senior undergraduate or Masters level, well versed in the disciplines needed for such a project. The maximum number of students per team is five (5) and the minimum shall be three (3). Any team that loses team members during the project can recruit a replacement.

5.2. At least one member of the team must be a Petroleum Engineering candidate with sufficient coursework completed to understand the physics relating to the drilling problems and the normal industry practices used to mitigate the problem.

5.3. Students with a background in mechanical and electrical engineering, as well as controls and automation or software development are most welcome.

5.4. A multi-disciplinary team simulates the working environment in the drilling industry today, as most products and services are produced with the cooperation of technical personnel from differing backgrounds and cultures.

5.5. A university may sponsor more than one team but must submit only one team/design for Phase II evaluation.

6. Expenditures

6.1. Teams selected to advance to the second phase must limit the cost of the rig and materials to US$ 10,000 or its equivalent in other currencies. The students shall find a source of funding and report the source in the Phase I proposal. All funding and procurement should comply with university policy. These funds are intended to cover the majority of expenses for hardware, software and labor to construct and operate the team's equipment. DSATS shall not be liable for any expenditure other than DSATS provided material and specified travel expenses.

DSATS will assist when possible obtain free PLCs or similar control devices from suppliers affiliated with the DSATS organization. Any team spending more than US$ 10,000 or its equivalent in other currencies be penalized for running over budget.

6.2. DSATS reserves the right to audit the team's and university's expenditures on this project.

6.3. Any devices built for the project will become the property of the university and can be used in future research and competitions. Any maintenance or operating costs incurred after the competition will not be paid by DSATS.

7. The design concepts shall be developed by the student team under the supervision of the faculty. Faculty and lab assistants should review the designs to ensure student safety.
8. Construction of the equipment shall be supervised by the student team, but may use skilled labor such as welders and lab technicians. The use of outside assistance shall be discussed in the reports and the final paper. DSATS encourages the students to gain hands-on experience with the construction of the rig since this experience will be helpful to the career of individuals in the drilling industry.
9. University coursework and credit

9.1. Each university will decide whether or not this project qualifies as a credit(s) towards any degree program.

10. Project Timeline

10.1.	Phase I - Design :	Fall term, 2015
10.2.	Submit final design to DSATS	31 Dec 2015, midnight UTC
10.3.	Submit an abstract to DSATS*	31 Dec 2015, midnight UTC
10.4.	DSATS to announce finalists by	15 Jan 2016
10.5.	Construction	spring term 2016
10.6.	Drilling Test specific on-site test dates at each university to be arranged not later than 31 March 2015. The testing will typically occur in late April or early May, hopefully before final exams.	
10.7.	Prepare and submit paper	Per SPE deadline
10.8.	Prepare and submit presentation	Per SPE deadline
10.9.	Present paper at ATEC	Per SPE and DSATS schedule

*DSATS will submit an abstract to the SPE that will include excerpts from the student abstracts by the conference deadline, mid Jan 2015. This will ensure consideration for this paper by the ATCE program committee.

11. Evaluation Committee

11.1. DSATS will select an evaluation committee (the Committee) from its membership.

11.2. Evaluation Criteria/Weighting

Criteria	Parameter	Weighting
Phase I:		
Safety	Safety	10
Mobility of rig	Rig up, move, rig down	5
Design considerations and lessons learned		10
Mechanical design and functionality, versatility		25
Simulation/Model/Algorithm		25
Control scheme		25
	Total	100%
Phase II:		
Construction quality of rig		5
Construction cost		10
	CAPEX	
	OPEX	
Lessons learned		10
Performance		25
Various parameters such as:	ROP	
	MSE	
	Cost per foot or meter	
	Optimal landing of bit	
Quality of wellbore		25
	Verticality	
	Tortuosity	
	Caliper	
Data		25
	Data handling	
	Data visualization	
	Total	100%

12. Prizes

12.1. The winning team will be sponsored by DSATS to attend the next SPE Annual Technical Conference and Exhibition.

12.2. Individual award certificates will be presented to all participants, with special certificates given to all finalists.

12.3. DSATS may provide extra awards, at its sole discretion.

12.4. The evaluation and all decisions on any matter in the competition of the DSATS judges and DSATS are final.

13. Terms and conditions

13.1. In no event will SPE, including its directors, officers, employees and agents, as well as DSATS members and officers, and sponsors of the completion, be liable for any damages whatsoever, including without limitation, direct, indirect, special, incidental, consequential, lost profits, or punitive, whether based on contract, tort or any other legal theory, even if SPE or DSATS has been advised of the possibility of such damages.

13.2. Participants and Universities agree to indemnify and hold harmless SPE, its directors, officers, employees and agents, as well as DSATS members and officers, and sponsors of the completion, from all liability, injuries, loss damages, costs or expenses (including attorneys' fees) which are sustained, incurred or required arising out of participation by any parties involved in the competition.

13.3. Participants and Universities agree and acknowledge that participation in the competition is agreement to all of the rules, regulations, terms and conditions in this document, including revisions posted to the DSATS website (see section 3).

13.4. Winning teams and finalists must agree to publication of their names, photographs and final paper on the DSATS web site.

13.5. DSATS and the SPE cannot provide funding to sanctioned individuals and organization per current US law.

13.6. Participants must comply with all local laws applicable to this contest.

14. Marketing

14.1. DSATS will provide a link on its website to all participating universities.

14.2. If university policy allows, various industry journals may send a reporter to witness the tests and interview students to publicize the project.

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