A PROGRESS REVIEW AND UPDATE ON A ROBOTIC AUTOMATIC WELL SERVICING SYSTEM

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ABSTRACT
This will be mostly a video review, update, and status of a complete new approach in well servicing that includes:

- A remotely operated robotic-automatic well services rig wherein there is no operating personnel within 100 feet of the wellbore.
- An integrated system for making up tubing as well as the two element rod connection to absolute computer precision.
- An integrated system for over the well electronic inspection systems of tubing and rods.

The stimulus for changing the way wells are serviced is quite simple as it goes without saying that too many accidents occur while servicing a well. In addition to the safety considerations, hiring and coordinating multiple contractors and crews to accomplish an objective can be inefficient and costly. There must be a better-safer way to conduct our business in the oilfield.

Safety First: There is an excellent SPE paper written by R. D. Hill (SPE-121056) that disclosed the fatalities in the "Oil and Gas Extraction" business. Over a five year period from 2003 to 2007, 526 workers lost their lives. Mr. Hill did not single out the well servicing business in the paper, but clearly the service industry was among his numbers. (Slide 1) Note that driving to and from work contributed the largest number of fatalities.

The Association of Energy Service Companies or AESC publishes various safety statistics dealing only with service rigs only. These numbers clearly indicate who has the accidents, where they occur, and what was hurt. (Slides 2 & 3).

The conclusion from these three slides is a no-brainer. A much safer workplace can be obtained if the number of workers is reduced and a machine is built that does not place the workers in harm's way.

The secondary catalyst for change is efficiency. (Slide 4) This data is derived from studying several thousands of rig hours, examining rig activity, and matching them to the written daily reports. Amazingly, less than half of the rig time is spent doing what the service rig is there to do: Run and pull rods and tubing. One of the largest contributors to waiting time was the rig waiting on a tubing scanning crew and often, the rig had to be shut down early because of availability. Just shutting down and getting the crew and truck out first thing in the morning was a common occurrence.

The third stimulus is crew recruitment, development, and retention. The youth of today are very comfortable with video games and animation. Moving something around on a screen is almost second nature to them, especially when they can operate the rig from a very comfortable chair in a controlled environment. Moreover, the operating system lends itself to computer training models much like the Microsoft Flight Simulator.™

The stage is set: Design a well servicing system with the following objectives:

- No personnel within fall lines while tripping
- Robotic in nature
- Automatic wherever possible with joy stick control for non-robotic task

- Use of a Fail Safe Mode in the event of a failure of any kind
- Use of a Lock Out Tag Out system to protect workers
- Operator is remote to rig in a controlled environment van
- Initial rig to have 100,000 pounds maximum pull back 2:1 safety factor (expandable)
- Proof of concept or prototype rig design for a 8000 foot well
- Elevator Speed at 4 feet per second for rods
- Elevator Speed at 2 FPS for tubing at loads less than 50,000 pounds
- Elevator speed at 1 FPS for loads greater than 50K
- Trip time for rods @ 5000' is 2 hrs
- Trip time for tubing @ 5000' is 3 hrs
- Precision control of connection make up (PLC)
- Double Rods (prototype)
- Single Tubing (prototype)
- Pick Up and lay down arm
- Free Standing
- True Vertical
- Data is transmittable
- Meet Class I Div I codes
- Fast rig up rig down
- Two man operation
- Expandable in nature allowing additions of hydrostatic testing, drilling, electronic inspection, electronic tally, electronic reporting, and coupling damage recognition.

The Process: Mapping out the process of designing, building, and testing this system can be reduced to four basic steps.

- Communicate and document the vision
- Find the right people
- Obtain the funding
- Go to work

During the design phase, as one might guess, there were many hurdles to jump.

A few examples:

Mechanical: A major mechanical obstacle was to build a true vertical well service rig that could be driven down the road, rig up on wells with pumping units, and be totally self-contained. Those three criteria severely limit the options that are available. (Slide 6)

PLC: This is to be an automatic rig, meaning lay down the pony rods using joy sticks, press a button and let the computers take over and pull rods or tubing. The oilfield has its own lingo. The PLC or computer worlds have their lingo. They are languages that do not understand each other. Communicating to the code writers the processes and lingo is a daunting task. After sitting down for hours going over every minute detail on how a joint of tubing is tightened and how the tong man uses the tubing tongs, the code writer reduced the process to what is seen in slide 7. That process repeated itself for every rig function and there are many. What is simple to the tong man becomes a complex series of IOs, events, signals, sensors, logic flow, and commands to the code writers.

More: If this rig is to be truly automatic, the logic systems must think like a rig operator, knowing when to be fast or slow, when to stop and start, avoiding over pulls, inadvertent stack outs, and the numerous tasks and processes that a conventional rig operator spontaneously performs while tripping.

CONCLUSION

The human being is a complex dynamic creation. This well servicing system is second unto it.

The prototype rig is built and is being programed and de-bugged. The presentation of this paper will be mostly a video presentation showing the rig in action.

Many of the systems utilized on this rig are patent pending.

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SPE 121056

Injury Risk Among Oil and Gas Extraction Workers by Company Type and Size

R.D. Hill, SPE, G.A. Conway, and P.D. Somervell, National Institute for Occupational Safety and Health

Table 1: Number of Fatal Injuries among U.S. Oil and Gas Extraction Workers by Type of Injury Event, 2003-2007[1]

Injury Event	Fatalities	% Total
Highway crash	151	28.7
Struck by object	109	20.7
Explosion	44	8.3
Caught or compressed in moving machinery or tools	41	7.8
Fall to lower level	36	6.8
Electric current	30	5.7
Fire	29	5.5
Aircraft crash	20	3.8
Other	66	12.5
Total	**526**	

[1]Data for 2007 are preliminary.

CHART 3 – TYPE OF INCIDENT

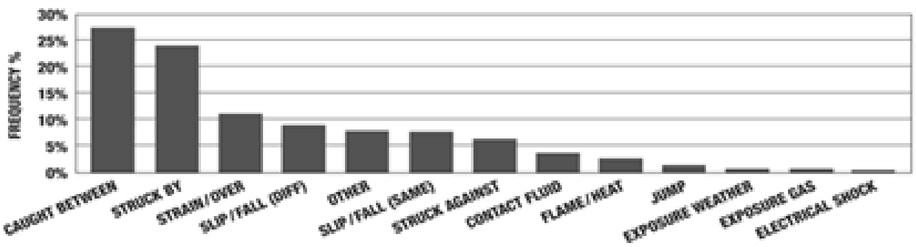


CHART 4 – EQUIPMENT INVOLVED WHEN INJURED

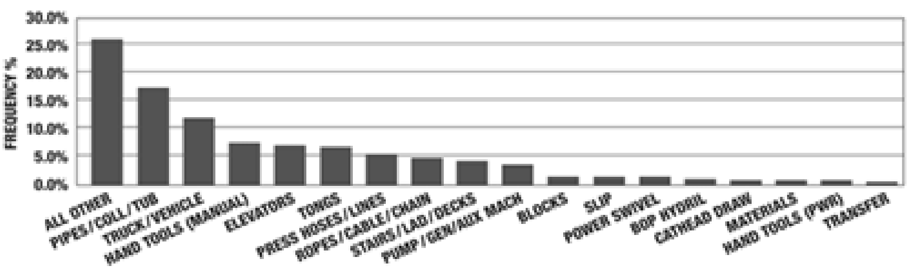


CHART 6 – PART OF BODY INJURED

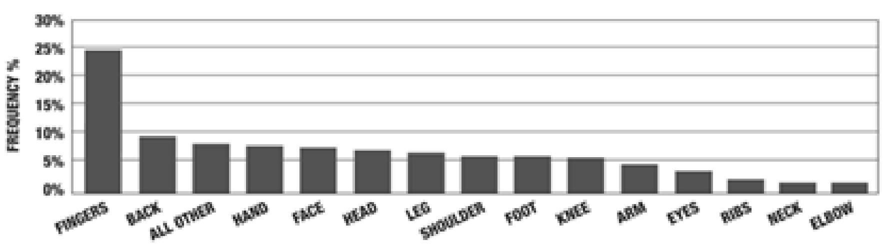
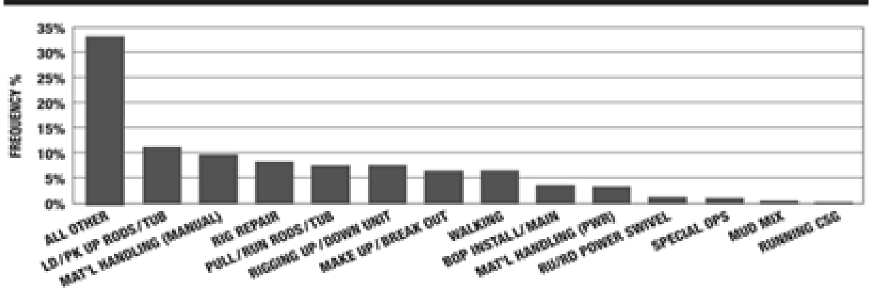


CHART 5 – ACTIVITY INVOLVED WHEN INJURED

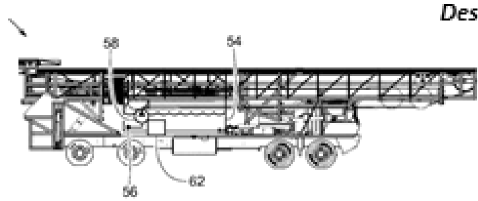


Rig Time Utilization Study for a Typical 5,000 well.

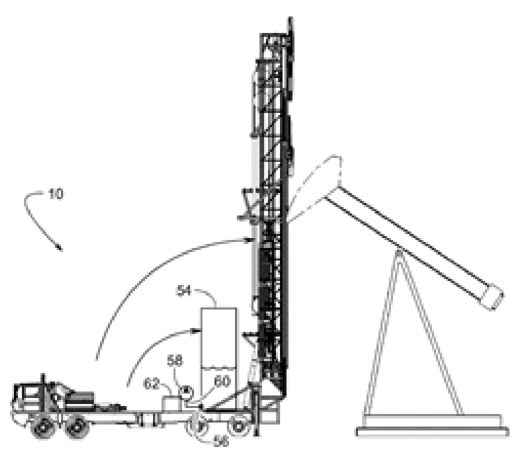
TASK	% RT
Trip Time defined of blocks moving up and down	40%
Changing over tools and wellhead work	20%
Waiting Time (Third party services/Waiting on orders)	14%
Start up/JSAs/Lunch/breaks	12%
Third Party Services (perforating/hot oil)	7%
Other	7%

Source: Remotely gathered rig data study.

Design Hurdles 6

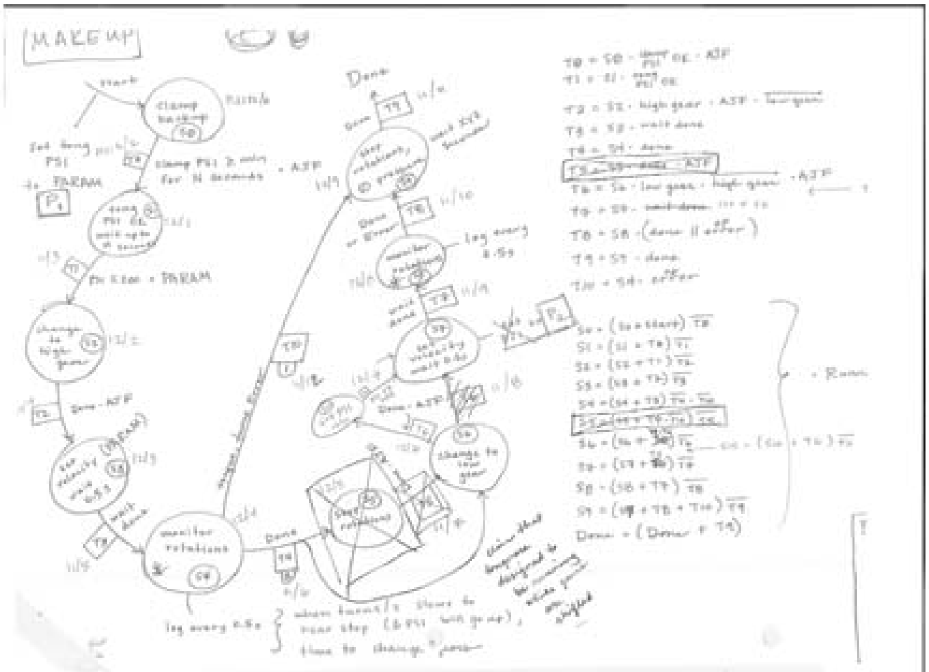


Street Legal
Maximum Height   14'
Width 10'
96,600 GVW



At Pumping Unit Wellsite

- **True Vertical**
- **Must work around walking beam**
- **Must be able to remove head**


MAKEUP
Done
monitor rotations
change to high gear
change to low gear
log every 2.5s
Done