Affordance Structure Matrix (ASM)

The analysis of USER and EQUIPMENT interaction on a Drilling Rig could help us to better describe and decide the type of equipment needed.

The AFFORDANCES of a Drilling Rig are what it provides, offers, or furnishes to the user. For example the Rig as a whole affords drilling a hole while the Iron Roughneck (IR) allows MU/BU of tubulars by eliminating the cathead.

These affordances between the Rig and the Crew can be called, **Rig-User-Affordances (RUA)**, but since the IR requires a dedicated space on the rig floor and extra consumption of energy is needed then we have an affordance between the IR and the Rig itself that is called **Rig-Equipment-Affordances (REA)**.

An important distinction between the affordances of a piece of equipment and its function is that the affordance depends on the physical form and features of the equipment, whereas the functions do not.

The fact that functions are form-independent is useful during the rig lay-out design process because it frees engineers to choose the **equipment that best accomplishes each function**. However, the fact that affordances are form-dependent can also be useful, because it allows engineers to analyze and compare the affordances of equipment concepts (especially at the system level) as well as of existing equipment for reverse engineering.

POSITIVE AND NEGATIVE AFFORDANCES

Another useful feature of the affordance approach is that it is able to describe intended as well as unintended aspects of the equipment. For example, a motor's function is to transform electrical energy into rotational kinetic energy. Thus, it affords rotary motion, which is desired and is therefore what we classify as a positive affordance. However, because of the various resistances inside the motor, the motor also generates heat, which is undesired and is therefore what we classify as a negative affordance.

By consciously analyzing both the positive and negative affordances of equipment concepts during the design process, negative affordances can be designed against or mitigated. A similar process is not supported by function-based approaches in which the functions simply capture the "intended" or desired functionality.

A useful tool allowing engineers to use the additional information captured by the affordance approach is the **Affordance Structure Matrix (ASM),** wherein the system level affordances are mapped to the rig's individual components. ASMs can be prepared for different device concepts or existing equipment, and then compared to each other or analyzed to attempt to improve various affordances.

There is also room to describe the quality of the affordances of a piece of equipment. For example, a rig hand can operate an IR just as easily as a Power Tong. They both possess the affordance of MU/BU fast and easily, but this affordance may require less space on the rig floor with the Power Tong than with the IR. By contrast, the basic function is the same—to MU/BU tubulars. In the case of old rig equipment compared to modern ones, we see that the basic functionality remains largely fixed over time, while the affordances have changed rather dramatically. Original positive affordances have been improved (such as speed and tubular manipulation), new positive affordances have been introduced (such as machine monitoring or embedded systems), and negative affordances (such as risks and accidents) have been significantly reduced.

The top captures which components are related to each other as in a traditional Design Structure Matrix (DSM).

		RF1	RF2	RF3	RF4	RF5	RF6	RF7	RF8	RF8	RF9	Pd1	Pd2	Pd3	WC1	WC2	DC1	DC2	DC3	DC4	MS1	MS2	MS3	MS4	PS1	PS2	PS3	HS1	HS2	Total
		Top Drive	Power Slips and Elevators	Roughneck	Upper Derrickman Arm	Rotating MH/MH Hoist/Hoist Assist	2 Arm Racker	Column Racker	Casing Stabbing / Derrick Access Basket	Casing Stabbing Arm	Top Drive Casing Running Tool	Catwalk Machine / Conveyor	Pipe Deck Machine / Pipehandling Crane	Horizontal to Vertical Machine	Minute Man	Auto-Well Response	Integrated Control Cabin	Single Chair	Double Chair	Triple Chair	Auto-Shaker Control	Sack Slitter	Auto-Mixing System	Mud Pump Remote-Downlink				Manual Break Auto Driller	Dynamic Friction Plate Auto Driller	
+ RUA	Hands free ops		●	●																										
	Cleaner work space	●		●																										
	Faster operation	●	●	●																										
	Safer operation		●	●																										
- RUA	Special training required	●		●																										
	Diminish rig floor skills	●	●	●																										
	Make operation bored																													
+ REA	Automatic features	●	●	●																										
	Condition monitoring																													
	Quick set up	●																												
- REA	Space required			●																										
	Down time if fails	●		●																										
	Power consumption			●																										
	Spares	●	●	●																										
	Total (+)	4	4	5																										
	Total (-)	4	2	6																										
	G-Total	8	6	11																										

The totals on the right show how many components are related to each affordance.

The left side captures which affordances are related to each other,

The interior of the matrix captures which components are related to each affordance.

The totals on the bottom show how many affordances each component is related to.