

NSRP | National Shipbuilding Research Program

spARky - Reducing Wiring Costs using 3D Model and Augmented Reality

NSRP Panel Meeting

July 29, 2015



Goals and objectives

- Deliver to the workforce the information needed for the job – only that information
 - With the ability to access additional information as needed
- Significantly reduce the time spent finding correct location
 - In congested work areas, AR is the best technical path to these goals.

spARky Background

- With the implementation of Siemens NX at EB the traditional method of using drawings to deliver wiring detail to the trades was challenged.
 - Wire Tables
 - Wiring Diagrams
 - Formboards
- NX provided the means to efficiently model and capture wiring within the electrical component.
- As a result the model itself now contains the necessary information to wire an electrical component.

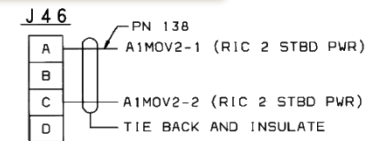
History of Wiring Drawings

- Wire table
- Wire diagram
- Formboard
- 3D Model

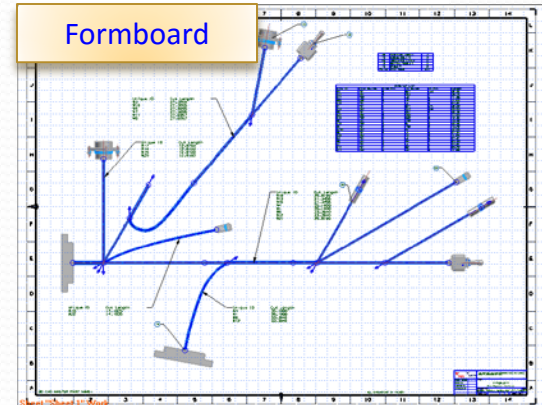
Wire Table

WIRE NO.	SIGNAL NAME	WIRE COLOR	WIRE P/N	TERMINAL P/N	MANUFACTURER	QUANTITY	TERMINAL P/N	REMARKS	REV
1	BLK TANK 1 SHUT/OISCH V DISCH SIGNAL CH A	WHT	1	J07	222AF400	1	14		01
2	BLK TANK 1 SHUT/OISCH V SHUT SIGNAL CH A	WHT	1	J07	181701	80	8		01
3	BLK TANK 1 SHUT/OISCH V SHUT SIGNAL CH A	WHT	1	J07	182AF400	2	14		01
4	BLK TANK 1 SHUT/OISCH V SHUT SIGNAL CH A	WHT	1	J07	221701	80	8		01
5	BLK TANK 1 SHUT/OISCH V DISCH SIGNAL CH A	WHT	1	J07	182AF400	2	14		01
6	BLK TANK 2 SHUT/OISCH V DISCH SIGNAL CH A	WHT	1	J07	221701	80	8		01
7	BLK TANK 2 SHUT/OISCH V DISCH SIGNAL CH A	WHT	1	J07	182AF400	2	14		01
8	BLK TANK 2 SHUT/OISCH V SHUT SIGNAL CH A	WHT	1	J07	221701	80	8		01
9	BLK TANK 2 SHUT/OISCH V SHUT SIGNAL CH A	WHT	1	J07	182AF400	2	14		01
10	BLK TANK 2 SHUT/OISCH V SHUT SIGNAL CH A	WHT	1	J07	221701	80	8		01
11	BLK TANK 2 SHUT/OISCH V SHUT SIGNAL CH A	WHT	1	J07	182AF400	2	14		01
12	BLK TANK 2 SHUT/OISCH V SHUT SIGNAL CH A	WHT	1	J07	241701	100	8		01
13	BLK TANK 2 SHUT/OISCH V SHUT SIGNAL CH A	WHT	1	J07	182AF400	2	14		01

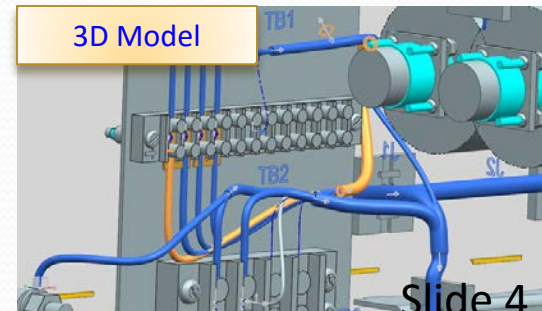
Wire Diagram



Formboard



3D Model



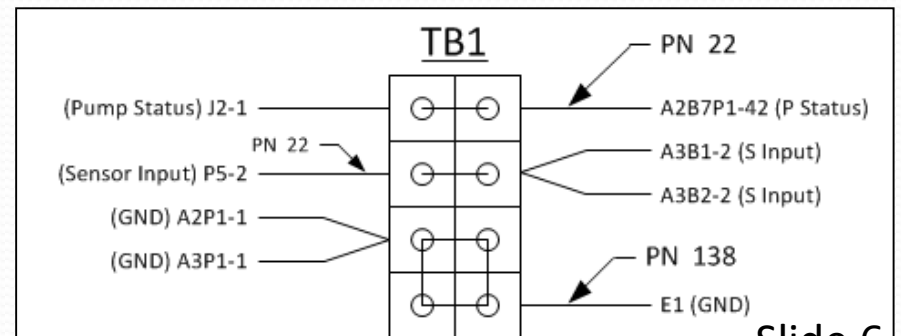
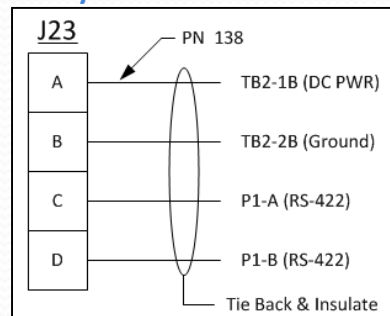
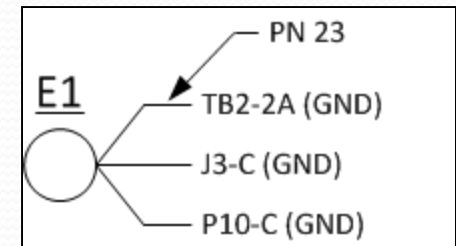
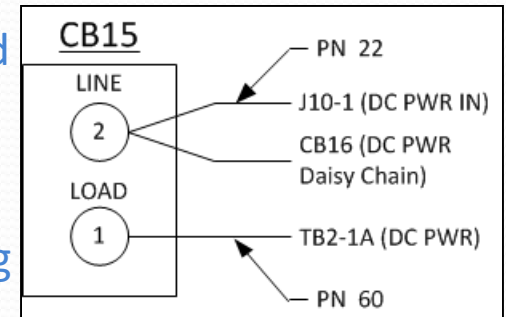
Wire Tables

LINE/ SEQ. NO	SIGNAL NAME	WIRE COLOR	WIRE P/N	TERMN P/N	FROM:		TO:		TERMN P/N	REMARKS	REV LVL
1	RECEIVE DATA	WHT	32		A5J51	2	A2A2J201	C27	14	SEE NOTE 7008	B6
2	TRANSMIT DATA	BLU			A5J51	3	A2A2J201	C28	14	SEE NOTE 7008	B6
3	SIGNAL GROUND	ORG			A5J51	5	A2A2J201	B31	14	SEE NOTE 7008	B6, 14
4	NODE ID JUMPERS	WHT	1	42	A2A2J201	C18	A2A2J201	C11	42		B4
5	NODE ID JUMPERS	WHT	1	42	A2A2J201	C17	A2A2J201	C13	42		B4
6	NODE ID JUMPERS	WHT	1	42	A2A2J201	C19	A2A2J201	C15	42		B4
7	NODE ID JUMPERS	WHT	1	42	A2A2J201	C20	A2A2J201	C16	42		B4
8	NODE ID JUMPERS	WHT	1	42	A2A2J201	C22	A2A2J201	C9	42		B4
9	RECEIVE DATA	WHT	32		A5J52	2	A2A17J201	C27	42	SEE NOTE 7008	B4, 6
10	TRANSMIT DATA	BLU			A5J52	3	A2A17J201	C28	42	SEE NOTE 7008	B4, 6
11	SIGNAL GROUND	ORG			A5J52	5	A2A17J201	B31	42	SEE NOTE 7008	B4, 6, 14
12	NODE ID JUMPERS	WHT	1	42	A2A17J201	C18	A2A17J201	C9	42		B6
13	NODE ID JUMPERS	WHT	1	42	A2A17J201	C17	A2A17J201	C10	42		B6
14	NODE ID JUMPERS	WHT	1	42	A2A17J201	C19	A2A17J201	C12	42		B6
15	NODE ID JUMPERS	WHT	1	42	A2A17J201	C20	A2A17J201	C14	42		B6

- Wire tables simply list the end points of each wire as well as the wire type, and reference to the termination type.
- In some cases a one line description of the signal carried by the wire is present.
- Wire tables were created manually by typing into a table generated in CATIA.

Wiring Diagrams

- Wiring diagrams use electrical symbols to represent wired components.
- Each line drawn to a symbol represents a wire which includes a reference to the wire part number.
- Wire termination information is controlled by the drawing notes.
- Signal descriptions are also sometimes included on wiring diagrams.
- Wire diagrams are created by importing images of the text from an excel file into CATIA, then resizing it to align with the symbol. The symbols are drawn from a user generated library.



3D Model

- The 3D model contains all the necessary information to wire an electrical component. This was not the case in the past.
- The process to model the harness is simple. Routing the harness is just a matter of dragging it in place.
- Building from the 3D was another area evaluated after the implementation of NX, and it met the business case. What remains incomplete is the delivery system of this information.

The screenshot displays a 3D CAD model of an electrical harness. The interface is divided into three main sections:

- 3D Model:** A central 3D view of the harness assembly with blue wires routed through a grey chassis.
- Wired Parts List:** A table on the right side of the interface listing parts with columns for Device ID, Component ID, and Part Name. A red circle highlights this section.
- Wire Table:** A table at the bottom of the interface listing wire details with columns for Wire ID, Part Number, From Conn, From Pin, To Conn, To Pin, Length, Color, OD, Signal Type, and EMI. A red circle highlights this section.
- EPL:** A table on the left side of the interface listing part numbers and descriptions, with a red circle highlighting it.

Wire ID	Part Number	From Conn	From Pin	To Conn	To Pin	Length	Color	OD	Signal Type	EMI
46	M22759-32-22-9C	3053	11	782	2A	32.949009		0.043000	DC	
44	M22759-32-22-9C	3053	11	782	2B	32.949009		0.043000	DC	
18	M22759-32-22-9C	3057	11	782	4B	14.720647		0.043000	DC	
17	M22759-32-22-9C	3058	11	782	4A	14.720647		0.043000	DC	
43	M22759-32-16-9C	782	2A	782	2A	0.000000		0.043000	DC	
17	M22759-32-22-9C	FAAN	11	782	11	1.788171		0.043000	DC	
45	M22759-32-16-9C	CR8	NC	CR8	NC	0.000000		0.043000	DC	
12	M22759-32-22-9C	W05	11	W05	11	0.000000		0.043000	DC	
42	M22759-32-22-9C	782	2A	826	6A	60.100072		0.043000	DC	
19	M22759-32-22-9C	782	2A	CR8	11	16.670385		0.043000	DC	
42	M22759-32-16-9C	182	1A	CR8	11	16.670385		0.043000	DC	
34	M22759-32-22-9C	J1	8	CR8	11	44.247043		0.043000	DC	

The screenshot displays a CAD software interface with three main components:

- Assembly Navigator (Left):** A tree view showing a hierarchy of parts. A red oval highlights a section of the list, including parts like MDLPRTO0705310, Constraints, OccNote 000091, and various part numbers such as 02-61-1238, 585-5325, 585-5356, 211005487, 16N852, 263500201, and 218071701.
- Photograph (Center):** A photograph of an open electrical control cabinet. It shows a complex arrangement of wires connected to terminal blocks and components. A green wire is highlighted, corresponding to the wire ID 46 in the table below.
- Wire List Table (Bottom):** A table with columns: Wire ID, Part Number, From Conn, From Pin, To Conn, To Pin, Length, Color, OD, Signal Type, and EMI. The table lists 17 wires with their respective connections and properties.
- Device ID Table (Right):** A table with columns: Device ID, Connector ID, and Part Name. It lists various connectors and their corresponding part numbers, such as XF3 (02-62-2111B), CB1 (M39019-04-2305A), J2 (211076085), and TB1 (211024720A).

Wire ID	Part Number	From Conn	From Pin	To Conn	To Pin	Length	Color	OD	Signal Type	EMI
46	M22759-32-22-9C	XDS3	(-)	TB2	3A	52.949409		0.043000	DC	
44	M22759-32-16-9C	CB3	NO	XDS3	(+)	3.574327		0.068000	DC	
38	M22759-32-22-9C	XDS7	(-)	TB2	4B	54.720647		0.043000	DC	
39	M22759-32-22-9C	XDS8	(-)	TB2	4B	55.632516		0.043000	DC	
43	M22759-32-16-9C	TB2	2A	CB3	C	55.753092		0.068000	DC	
27	M22759-32-22-9C	FAN1	(-)	TB2	3B	33.995898		0.043000	DC	
45	M22759-32-16-9C	CB3	NC	XDS4	(+)	12.339174		0.068000	DC	
12	M22759-32-22-9C	XDS5	(+)	XF1	LOAD1	5.188171		0.043000	AC	
20	M22759-32-22-9C	TB2	2A	XDS6	(+)	60.100072		0.043000	DC	
29	M22759-32-22-9C	TB2	2B	CB4	LINE (1)	58.075195		0.043000	DC	
42	M22759-32-16-9C	TB2	1A	CB3	Line 2	56.127740		0.068000	DC	
34	M22759-32-22-9C	J1	B	XDS7	(+)	44.267043		0.043000	DC	

Device ID	Connector ID	Part Name
Work Part		
MDLPRTO007053...	XF3	02-62-2111B
	CB1	M39019-04-2305A
	J2	211076085
	XF2	02-62-2111B
	TB3	39TB4
	E1	
	XDS1	218071701
	CB4	2/2/7274
	FAN1	218071917
	FL1	20vB6
	XDS7	218071701
	CB3	M39019-04-2245A
	CB2	M39019-04-2245A
	TB2	211024720A
	XDS8	218071701
	XDS5	218071701
	PS1	218067043
	XDS2	218071701
	XF1	FHL10GA
	J1	M28840-12AB151
	XDS6	218071701
	XDS3	218071701
	XDS4	218071701
	TB1	211024720A

- **Engineering Parts List (EPL):** all modeled parts including part numbers.

The screenshot displays a CAD software interface with three main components:

- Assembly Navigator (Left):** A tree view showing the assembly structure, including parts like MDLPRTO00705310 and various constraints and notes.
- Photograph (Center):** A photograph of a physical wiring harness installed in a metal enclosure, showing various connectors and wires.
- Wire Table (Bottom):** A table listing wire specifications. A red oval highlights the following row:

Wire ID	Part Number	From Conn	From Pin	To Conn	To Pin	Length	Color	OD	Signal Type	EMI
46	M22759-32-22-9C	XDS3	(-)	TB2	3A	52.949409		0.043000	DC	
- Device ID Table (Right):** A table listing device IDs and their corresponding connector IDs and part names.

Device ID	Connector ID	Part Name
Work Part		
MDLPRTO007053	XF3	02-62-2111B
	CB1	M39019-04-2305A
	J2	211076085
	XF2	02-62-2111B
	TB3	39TB4
	E1	
	XDS1	218071701
	CB4	2/2/7274
	FAN1	218071917
	FL1	20V86
	XDS7	218071701
	CB3	M39019-04-2245A
	CB2	M39019-04-2245A
	TB2	211024720A
	XDS8	218071701
	XDS5	218071701
	PS1	218067043
	XDS2	218071701
	XF1	FHL10GA
	J1	M28840-12AB151
	XDS6	218071701
	XDS3	218071701
	XDS4	218071701
	TB1	211024720A

- **Wire Table:** To/From connections, wire type, wire part number, signal type, length etc.

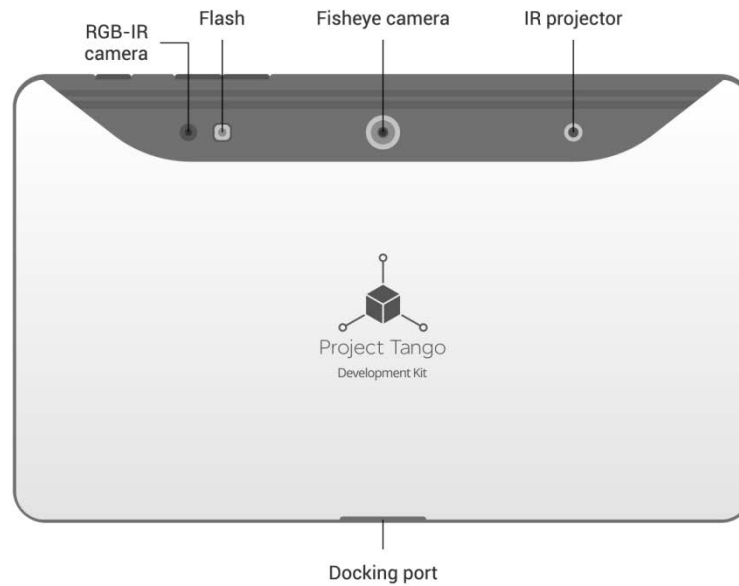
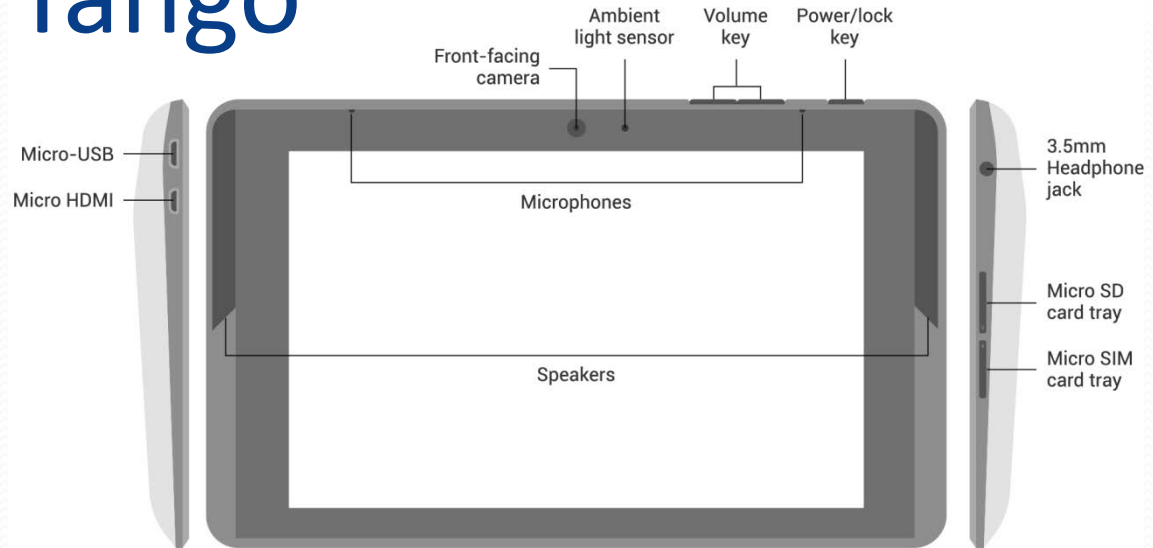
AR use cases

- Tracking
- General location
- Labeling
- Data retrieval
- -----
- Pickability
- Status
- Lean workpackage

Project Plan

- Phase I
 - CAD viewer
 - Select wire -> display connectors
 - Sorting
 - Manual status
 - Prep for AR
- Phase II
 - AR
 - Tracking
 - Labeling
 - Pickability

Google Tango



Google Tango

- **Screen**
 - 7.02" 1920x1200 HD IPS display (323 ppi)
- **OS**
 - Android™ 4.4 KitKat®
- **Memory**
 - 128 GB internal storage (actual formatted capacity will be less)
 - 4 GB RAM
- **Processor**
 - NVIDIA Tegra K1 w/ 192 CUDA cores

Sparky: AR in the small

