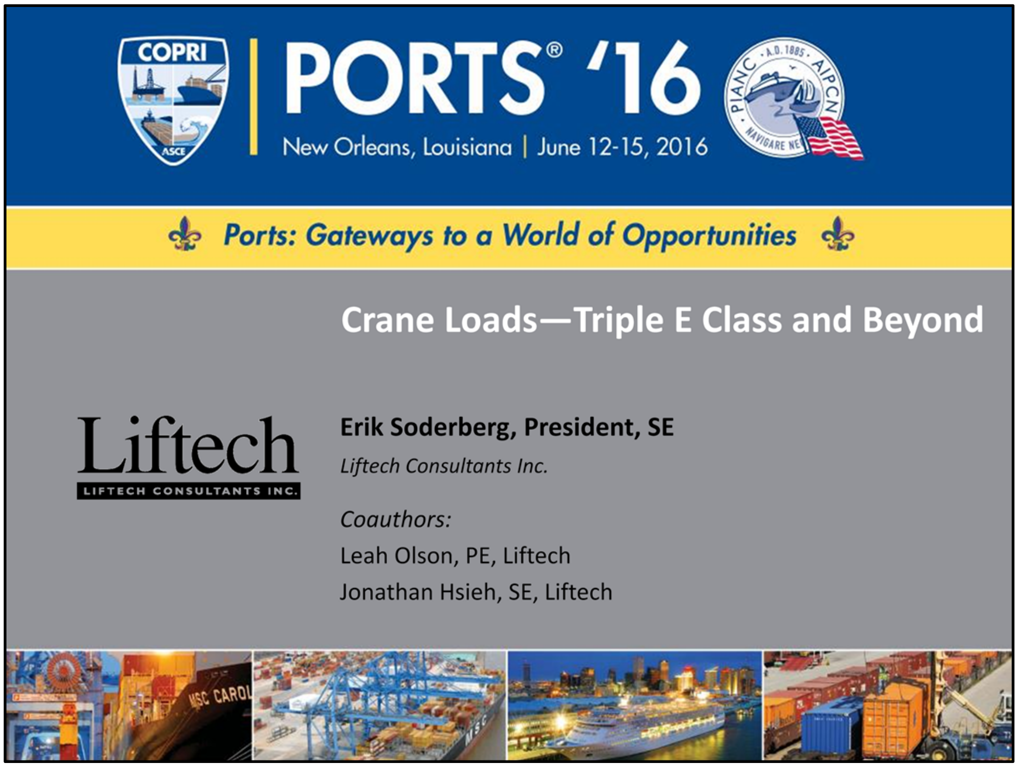
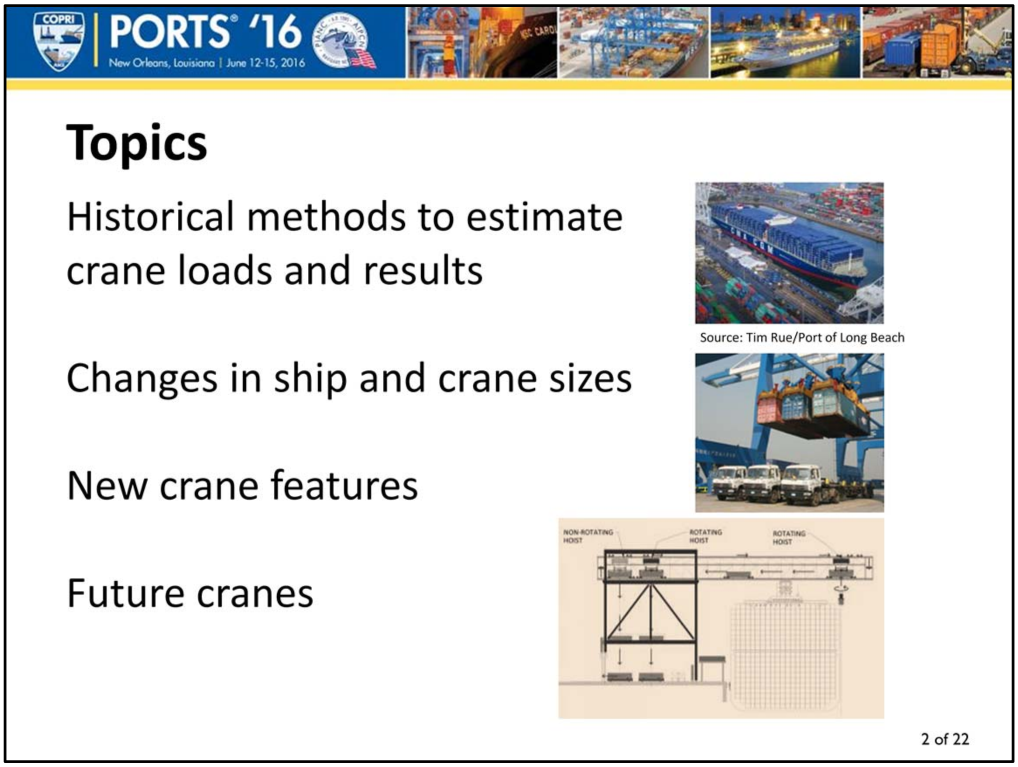
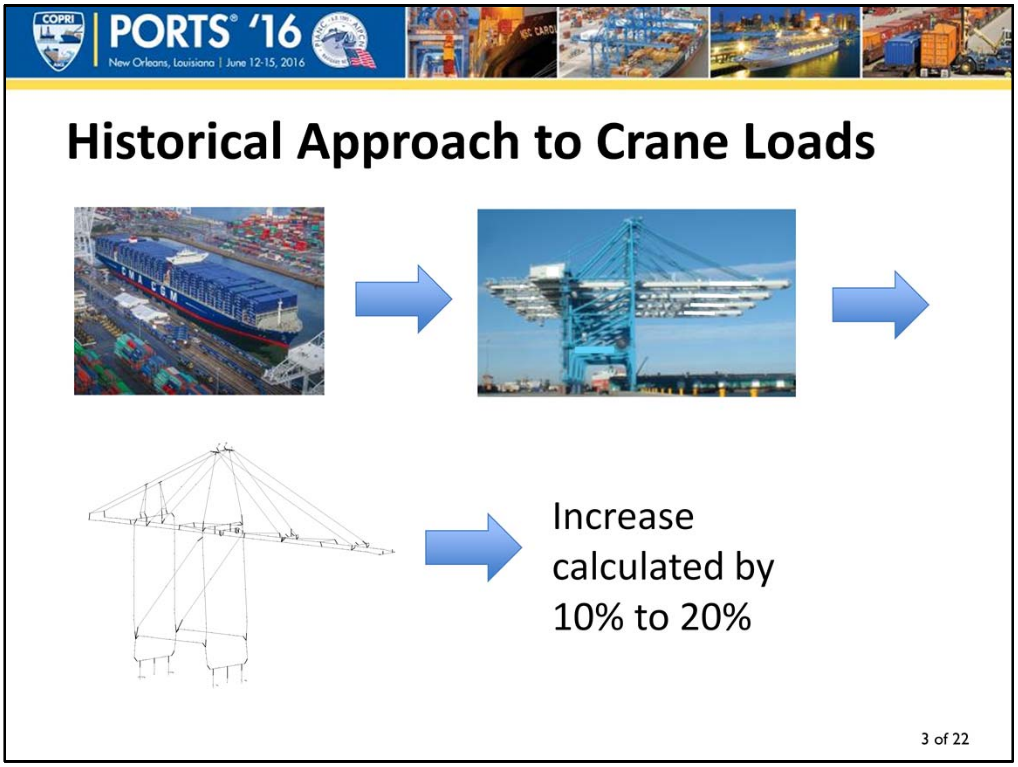


Liftech Consultants Inc. is a consulting engineering firm, founded in 1964, with special expertise in the design and procurement of dockside container handling cranes and other complex structures. Our experience includes structural design for wharves and wharf structures, heavy lift structures, buildings, container yard structures, and container handling equipment. Our national and international clients include owners, engineers, operators, manufacturers, and riggers.

Erik Soderberg is Liftech's president. He has over 20 years of experience in the design, review, and modification of a variety of structures including container cranes, wharves, heavy lift equipment, various rigging structures, and buildings. Erik has consulted on hundreds of cranes, participated in the design of over two dozen wharf structures, and has designed many crane transfer systems ranging from curved rails to shuttle systems. He has engineered repairs and modifications for dozens of container crane structures and for several bulk loaders. His field skills include an understanding of heat straightening techniques and the ability to develop repair procedures on-site.



Vessels and STS cranes have changed rapidly.



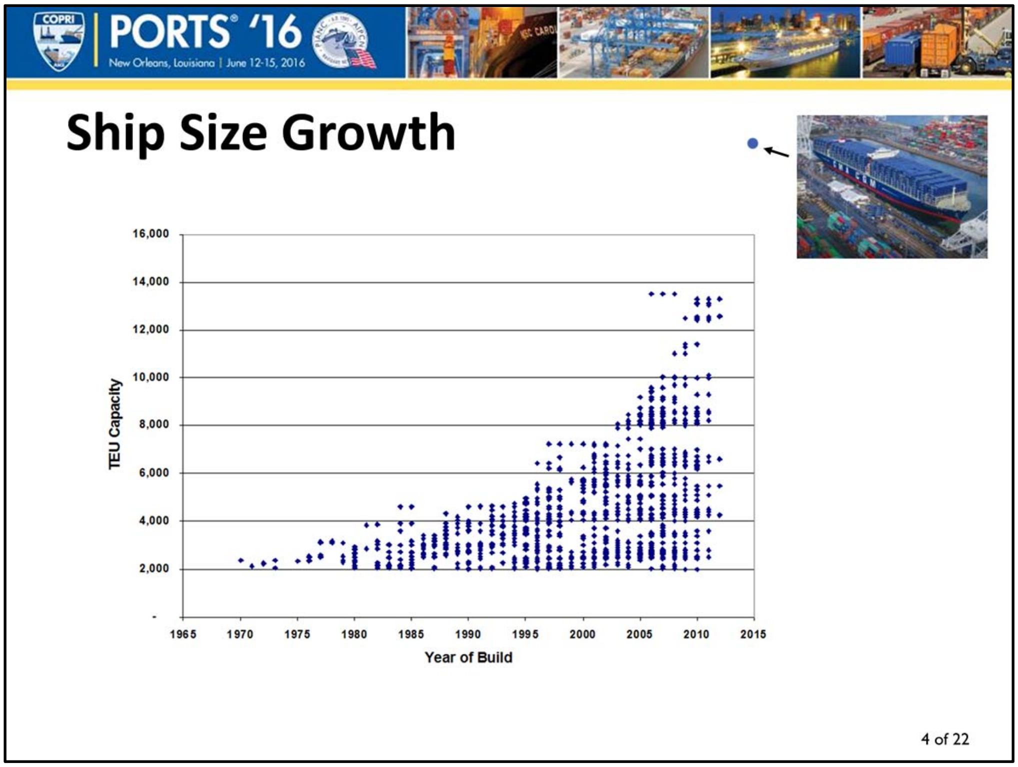
The historical approach to determining crane design loads was:

Designers estimated the largest expected ship for design life of facility

Designers estimated the crane size to service the ship

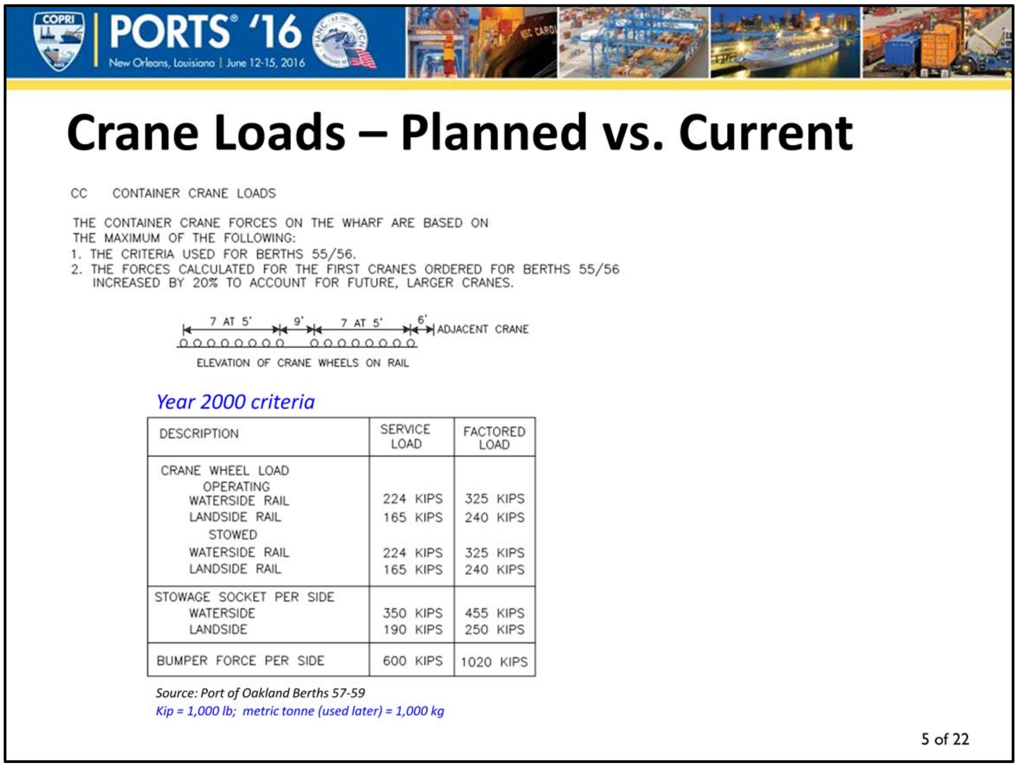
Designers increased estimated loads 10% to 20%

This worked well for years, but recently crane loads have exceeded wharf design loads much sooner than expected.



This is a graph of container ship sizes and the year the ships were built.

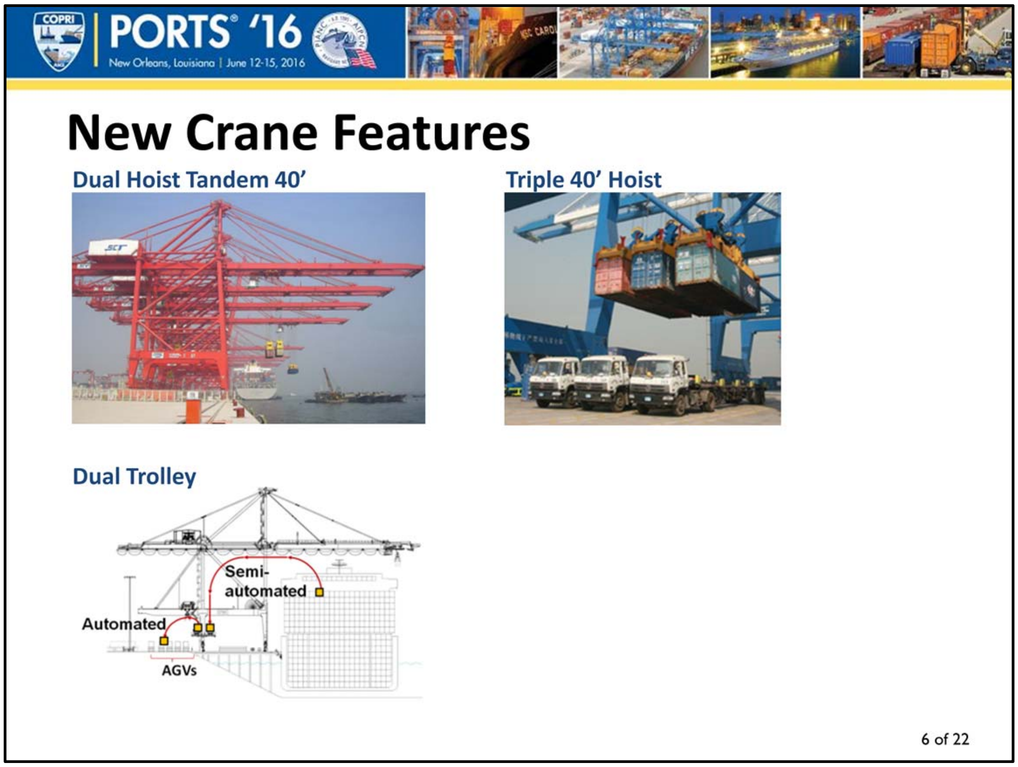
Ship sizes have recently grown more rapidly than expected.



DESCRIPTION	SERVICE LOAD	FACTORED LOAD
CRANE WHEEL LOAD		
OPERATING		
WATERSIDE RAIL	224 KIPS	325 KIPS
LANDSIDE RAIL	165 KIPS	240 KIPS
STOWED		
WATERSIDE RAIL	224 KIPS	325 KIPS
LANDSIDE RAIL	165 KIPS	240 KIPS
STOWAGE SOCKET PER SIDE		
WATERSIDE	350 KIPS	455 KIPS
LANDSIDE	190 KIPS	250 KIPS
BUMPER FORCE PER SIDE	600 KIPS	1020 KIPS

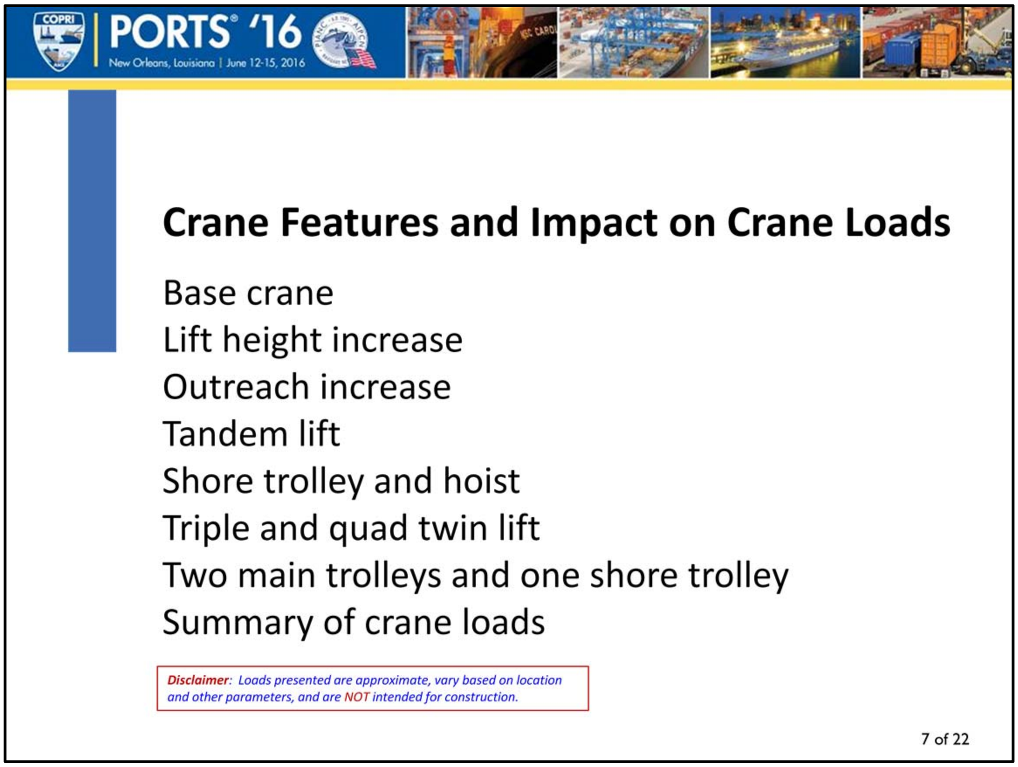
Crane wheel loads have increased more rapidly than expected as well.

Loads for many recent cranes now match the design loads used for the Port of Oakland Berths 57-59 wharf, only 15 years after design.



In addition to ship sizes growing faster than expected, the increased demand for crane productivity is resulting in crane variations that have a significant effect on wheel loads.

Note that dual hoist cranes are being used. Triple 40' hoist cranes are only at one location that we know of.

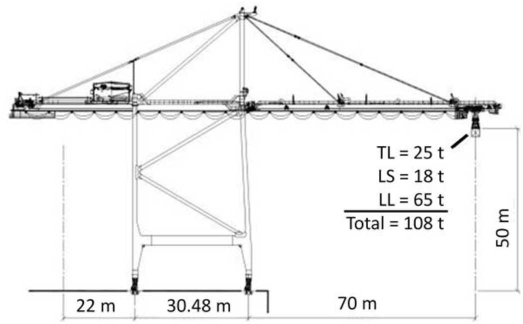


A variety of crane variations will be presented to explain their impact on crane wheel loads.

Base Crane

<u>Note</u>
Wheel loads are "Service" (ASD) level, assuming eight wheels per corner, 1.5 m wheel spacing.

Loads are based on the operating condition only, not including overload or storm wind.



	Landside Wheel Load tonne/wheel		Waterside Wheel Load tonne/wheel	
	Total	Change from Base Crane	Total	Change from Base Crane
Base Crane	66	0	91	0

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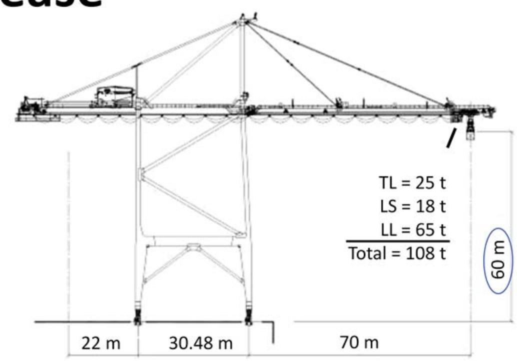
For this presentation, this is a base crane with 100' gage and 108 metric ton moving load, with lift height of 50 m, outreach of 70 m, and backreach of 22 m.

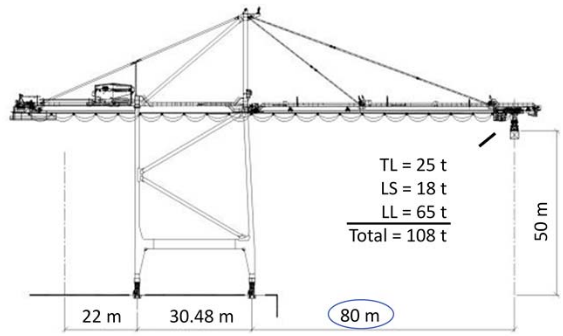
Lift Height Increase



	Landside Wheel Load tonne/wheel		Waterside Wheel Load tonne/wheel	
	Total	Change from Base Crane	Total	Change from Base Crane
Base Crane	66	0	91	0
Increased lift height	70	4	95	4

If the base crane lift height is increased 10 m, the landside and waterside wheel loads increase about equally, a relatively small amount.

Outreach Increase



	Landside Wheel Load tonne/wheel		Waterside Wheel Load tonne/wheel	
	Total	Change from Base Crane	Total	Change from Base Crane
Base Crane	66	0	91	0
Increased lift height	70	4	95	4
Increased outreach	61	-5	101	10

A small increase can be accommodated by modifying the boom tip.

Larger increases may require separating the boom between stays, with new outer stays and additional reeving.

Waterside wheel load increases marginally.

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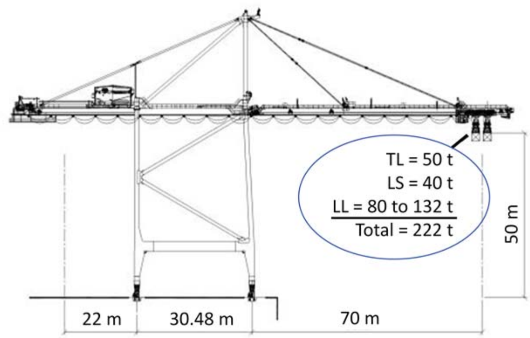
Tandem Lift



	Landside Wheel Load tonne/wheel		Waterside Wheel Load tonne/wheel	
	Total	Change from Base Crane	Total	Change from Base Crane
Base Crane	66	0	91	0
Increased lift height	70	4	95	4
Increased outreach	61	-5	101	10
Dual hoist tandem lift	94	28	127	36

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Can hoist:

2x 40' containers

4x 20' containers

Can be single or dual hoist.

Landside and waterside wheel loads are considerably higher than the base crane.

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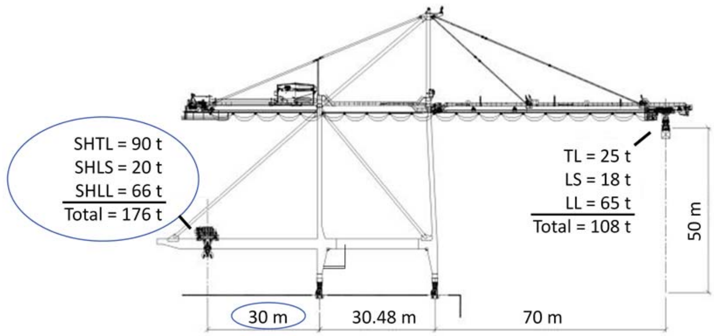
Shore Trolley and Hoist



	Landside Wheel Load tonne/wheel		Waterside Wheel Load tonne/wheel	
	Total	Change from Base Crane	Total	Change from Base Crane
Base Crane	66	0	91	0
Increased lift height	70	4	95	4
Increased outreach	61	-5	101	10
Dual hoist tandem lift	94	28	127	36
Shore trolley	120	54	123	32

Conventional for automated operations.

Ship hoist is manual with semi-automated features.

Short hoist can be automated.

Platform on crane at landside leg for setting containers.

Landside wheel loads increase due to shore trolley at backreach.

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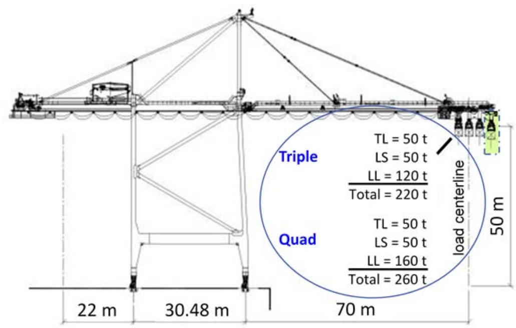
Triple and Quad Twin Lift



	Landside Wheel Load tonne/wheel		Waterside Wheel Load tonne/wheel	
	Total	Change from Base Crane	Total	Change from Base Crane
Base Crane	66	0	91	0
Increased lift height	70	4	95	4
Increased outreach	61	-5	101	10
Dual hoist tandem lift	94	28	127	36
Shore trolley	120	54	123	32
Triple lift	96	30	137	46
Quad lift	104	38	154	63

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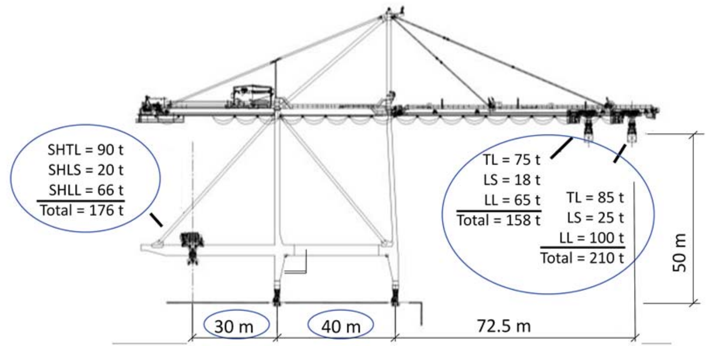
Triple has been used, but is uncommon, mainly for empty containers … has dual hoist, with one conventional headblock and one separating headblock.

Quad has not been used. Could use dual hoist with two separating headblocks.

Similar increase pattern as dual hoist, but higher loads.

Two Main Trolleys and One Shore Trolley



	Landside Wheel Load tonne/wheel		Waterside Wheel Load tonne/wheel	
	Total	Change from Base Crane	Total	Change from Base Crane
Base Crane	66	0	91	0
Increased lift height	70	4	95	4
Increased outreach	61	-5	101	10
Dual hoist tandem lift	94	28	127	36
Shore trolley	120	54	123	32
Triple lift	96	30	137	46
Quad lift	104	38	154	63
Two main trolleys and one shore trolley	182	116	175	84

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Platform on crane at landside leg for setting containers.

Loads could depend on limitations to main trolley travel at backreach.

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Summary of Crane Loads*

	Landside Wheel Load tonne/wheel		Waterside Wheel Load tonne/wheel	
	Total	Change from Base Crane	Total	Change from Base Crane
Base Crane	66	0	91	0
Increased lift height	70	4	95	4
Increased outreach	61	-5	101	10
Dual hoist tandem lift	94	28	127	36
Shore trolley	120	54	123	32
Triple lift	96	30	137	46
Quad lift	104	38	154	63
Two main trolleys and one shore trolley	182	116	175	84

**Service level wheel loads, eight wheels per corner, 1.5 m average spacing. Wharf girder allowable loads depend on wheel spacing.*

Disclaimer: Loads presented are approximate, vary based on location and other parameters, and are NOT intended for construction.

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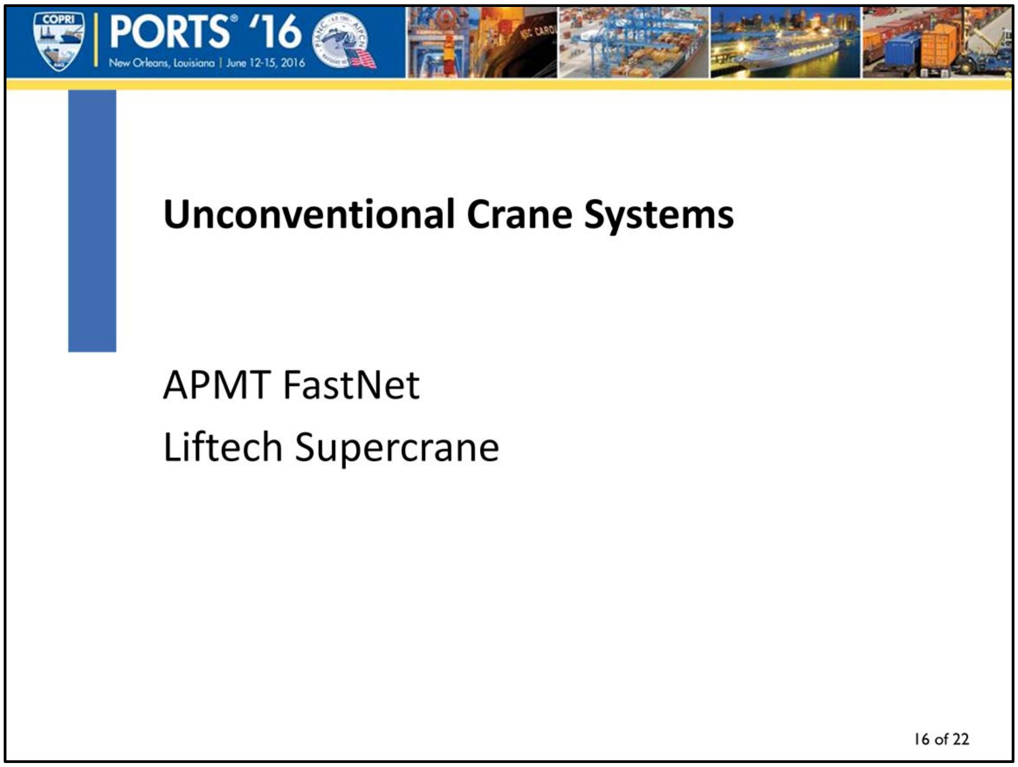
Approximate … actual loads will vary. Based on recent ZPMC cranes.

As mentioned, the study assumes 8 wheels/corner, with 1.5 m (5 ft) average spacing.

Increasing the number of wheels at one corner, with reduced wheel spacing, will <u>not</u> affect the wharf girder or pile design.



There are a variety of unconventional crane systems that are currently only concepts that may be developed within the life of wharves being designed now.

I will present two of these to show how they vary and to illustrate how drastically different their loadings will be from today's crane systems.

Bear with me if you heard my last talk about these systems.

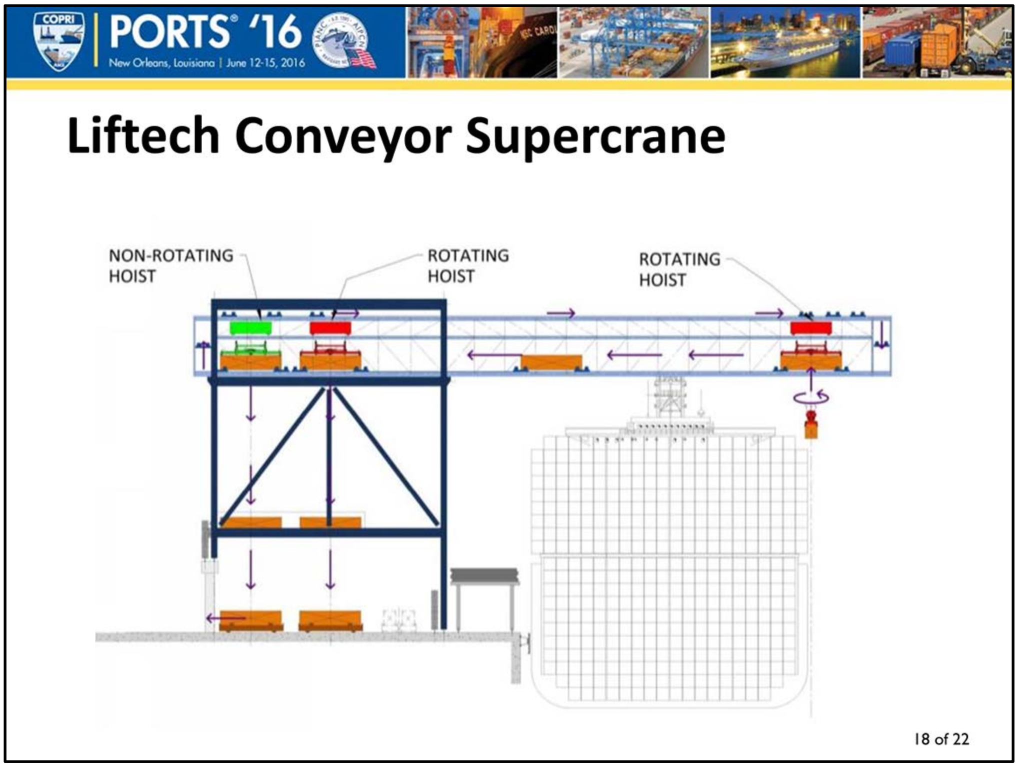
This concept system is the APMT FastNet system developed in detail about seven years ago.

It is an elevated crane system for access to adjacent vessel hatches.

Fixed elevated girders are used at the landside to facilitate yard equipment access under the cranes.

Waterside girder supports are movable, permitting some flexibility in crane deployment, but also resulting in large wharf loads. Double sets of wheels are required in the foot of the movable support, and rope equalized wheel systems are used to equalize the double line of wheels and limit costs.

The wharf loads for this system far exceed those of the more conventional systems presented previously.



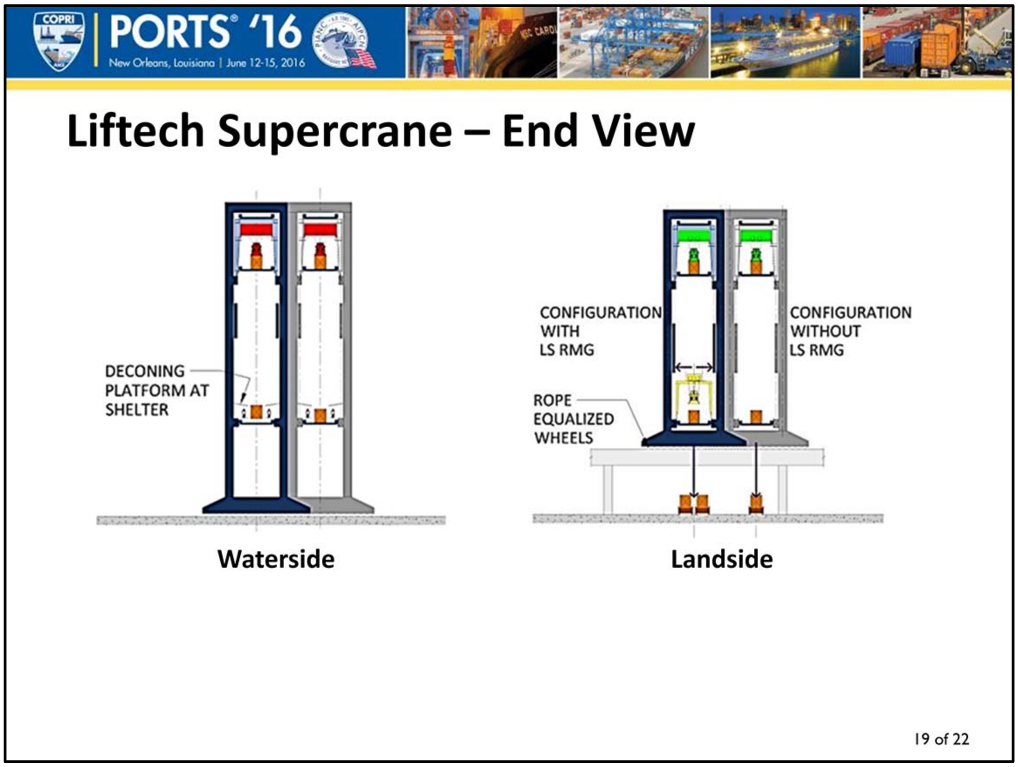
The Liftech Supercrane concept was conceived in the 1980s.

It involves rotating lifted containers so narrow cranes can be used, permitting cranes at adjacent vessel hatches. See next slide for end view.

This slide shows the container movement from the ship to the shore.

> The waterside hoist lifts and rotates the container and sets it onto carts, one on either end of the container.
> The carts move the container along rails to the landside hoist.
> The landside (non-rotating) hoist lowers the container.
> The carts continue to the landside end of the boom and an elevator system lifts them to an upper conveyor rail that they travel along to get to the waterside end of the boom where they are lowered.

Multiple hoists can be provided both at the landside or waterside.



This system has separate rails for adjacent cranes, for nesting of gantry and improved stability.

The wharf loads for this system also far exceed those of the more conventional systems presented previously.

Conclusion

The conventional approach may not be appropriate.

Stakeholders should consider a variety of crane features and the possibility of future unconventional systems, and perform a cost study to make intelligent decisions.

Appropriate design crane loads can avoid costly future wharf strengthening.

Consider additional cost to provide added capacity and designing for potential future modifications.

Lykes Flyer … first commercial cargo vessel to call at PONO post-Katrina.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