A New Transportation Category

Air transportation of standard shipping containers at much lower cost than current air cargo and much faster, direct service than ocean container ships.

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add CL for 1-2 TEU or 53". wing extensionszs

Cargo is shipped world wide in standard containers. Currently aircraft transport a small portion of high value, time sensitive cargo at high cost. Ocean ships require containers be delivered to port and collected until hundreds or thousands are available for transport to a destination port. Finally the containers are transported to their destinations. This is inconvenient, costly and slow. There is a great demand for faster, direct service at lower cost than the current air freight. Many shippers would pay a premium over ocean ship rates for time sensitive, high value cargo. The expensive frustrating research into lighter than air and wing in ground effect ideas demonstrates the demand for something better.

ConcordLift ™ implements all the well known factors for maximum efficiency. Spanload and laminar-flow control are combined with the highest possible aspect ratio. Existing configurations are unable to develop a design with the necessary very thick wing to contain containers and have a great aspect ratio. Laminar, boundary layer flow control has long been known to provide great reduction in drag but has not been possible to implement. This proposal is a novel configuration of multiple wings and two stage landing gear. The low wing load permits low speed, low power flight, very short runway, non pressurized, low construction cost, very long range and high efficiency.

Many existing airfields may be modified to operate this. A span loader has no limitation of wingspan. The suggested initial ConcordLift ™ aircraft proposes a runway of 1000 ft. long and a width from 600 to 1200 ft. Landing gear could be designed for unpaved surfaces.

ConcordLift ™ provides fast frequent service, direct from continental interiors to destination. ConcordLift ™ is competitive with ferry, truck and railroad in many places. This is a thought experiment and call for research and development. This configuration and operation have no antecedents. There is very little for references.

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I. Introduction.

Standard Containers are measured in Twenty-foot Equivalent Units (TEU) 20 ft. × 8 ft. usually 8.5 ft. high. One TEU has a 20 ft. wingspan and a thickness about 10 ft. to allow for structural elements above and below. A nominal slow wing has a thickness about 10% of chord. That results in a chord of 100 ft. for 2,000 sq. ft. for one TEU. The average load per TEU is 30,000 lb. This results in a very low wing load 15 lb. / sq. ft. That very low wing load means that is is possible to transport very heavy loads by an aircraft. A ten TEU, load of 300,000 lb. has wingspan of 200 ft. for an unacceptable aspect ratio of 2. The question is how to provide a great AR? ConcordLift ™ suggests the containers be carried in 300 ft. sections that are connected on the ground and fly as one wide aircraft. Two sections have an AR of 6 and three sections have an AR of 9 for very good efficiency.

ConcordLift ™ is a configuration not a design for any single aircraft. Deeper cord with more channels for containers are possible. Illustrations show cords up to 200 ft. with 6 channels of containers. A 150 ft. cord can hold four channels of containers that increases the wing load to 40 lbs. per sq. ft. ConcordLift ™ can be designed to meet wide variation in specifications. Instead of containers, bulk carrier, automobile ferry, sea control, and many other designs may be developed with gross weights reaching over 10 million lbs. This configuration creates the heaviest lift at the lowest possible cost. There is no theoretical possibility for improvement that cannot be incorporated into this configuration.

The very thick, deep cord wing creates a serious problem existing aircraft do not have. Very large, deep chord wings are not stable landing and taking off. Close to the surface a venturi forms between wing and ground. When the trailing edge is closest to the ground the low pressure pulls the trailing edge even closer to the ground. Rotation and flare creates major instability, flaps and ailerons hang down and create an even tighter venturi. Only slats and spoilers are possible. The cargo airfoil must localize that venturi with the shortest distance between wing and ground near the center of lift. This is accomplished with an inverted airfoil. This also eliminates the need for take-off and landing rotation and flare. On the ground an inverted airfoil can have a maximum angle of attack of about 5.7°. Additional lift is desirable.

It is not desirable and may not be possible to enlarge any existing configuration to control an aircraft with a 900 ft. wingspan and 100 ft. cord and larger. The control surfaces needed and additional lift for take off are provided by auxiliary, tandem wings mounted high over the main cargo pod airfoil. The auxiliary wings can have any control surface or lift augmentation device slats, flaps, ailerons, spoilers. They are mounted on fins that have rudders.

Even with the inverted airfoil, the venturi creates a great low pressure between the wing and ground. This must be overcome for flight. As the distance between wing and ground increases on take off, instabilities will occur. A complex two stage landing gear provides positive control and management of the instabilities. Main gear sets, similar to existing aircraft, are distributed under the spanloaded sections. Sets of stabilizing gear are emplaced in sponsons underneath each section. That gear has very large wheels, perhaps 10 ft. in diameter. they are mounted on gear legs that extend. On the ground the bottom of the cargo wing pod is about 10 ft. above the ground. As the wings develop lift, they leave the ground while the stabilizing gear still carries part of the total load. When the bottom of the wing is high enough so the venturi has lost force the stabilizing gear also lift off.

ConcordLift ™ appearance is unusual. Form follows function. The unusual configuration, appearance, permits large numbers of standard shipping containers, very heavy loads, to be flown economically.

II. Technical. Sections

A. Potential

There were 26 million TEU, with over 5 million in transit. Moving one percent would require 1000s of ConcordLift™ aircraft.

The initial target routes are third world. They have much higher rates than given below. The ConcordLift™ values are computed for a smaller version. In operation income could be 2 or 3 times larger.

However:

Shanghai to Los Angeles rates $5,605 per 40ft box[2] (2 TEU). The ConcordLift™ would cover the 6500 miles in about 54 hours. with potential of 3 flights a week. At container ship rates it would earn close to $375,000 a week for the smallest 45 TEU version. For a container to travel from Chengdu to Chicago ground transportation is additional. ConcordLift™ would travel direct with great saving in time and expense.

One runway, one 45 TEU ConcordLift™ every 5 minutes is 540 TEU per hour, 12960 TEU per day. The entire port of New York handled 20274 a day in 2019.[3]

Ro-Ro ships require one month's new car production to fill. More than two month's wait before the capital outlay becomes income. ConcordLift™ holds one day's production, permitting filling special orders.

First world truck rates are near $.40 ton / mile. The ConcordLift™ 45 TEU version, at that rate, earns $160,000 in 8 hour, providing faster delivery at lower cost.

First world train rates are around $.10 ton / mile for unit trains. The ConcordLift™ 45 TEU version, at that rate, earns $40,000 in 8 hours.

There are hundreds of millions of people in Indonesia, the Philippines, central Asia, Africa, and elsewhere that have no access to low cost speedy transportation.

B. Basic Design Form

There is no inherent limit to the span of a spanloader. The projected usage would be a wide wingspan on a short field. The initial suggestion would be three sections for a combined wingspan of 900 ft. AR 9, 45 TEU, 1,350,00 lb. load. Alternatively 600 ft. - 6AR and 1200 ft. -12 AR wingspans could be used. The multiple 300 ft. sections facilitate ground handling. A 300 ft. 15 TEU, 450,000 lb. load section could fly with an aspect ratio of 3. ConcordLift™ is very large. Many existing airports could be modified to handle it. It could be designed for unpaved fields. The flight parameters are those of a plane with a similar wing load. Different intended usages could lead to different flight parameters. ConcordLift™ would use the same runway length as a light plane. The smallest version, one container, could operate from a grass strip 100 ft. by 1000 ft. It can serve almost anywhere.

C. Auxiliary Tandem Wings, adjustable incidence

The auxiliary tandem wings are mounted on pivots so their angle of attack can be changed. They provide the rotation and flare for take off and landing. They have ailerons, flaps and slots. At optimum angle of attack, with high lift devices, a wing can produce 2 1⁄2 times as much lift as normal. If the auxiliary wings are 20% of the combined wing area, at optimum angle of attack, they provide 5/13 of total lift. The total lift of the ConcordLift ™ is not determined by the deep chord cargo wing portion alone. Wings work together in harmony, "Concord", to accomplish what otherwise cannot be done. The motion between the auxiliary wing and the cargo pod is buffered.

D. Yaw and Pitch

At the front and rear of the cargo wing are vertical fins connecting to the auxiliary wings above. One function is to carry tension, lift, from the auxiliary tandem wings to the cargo wing. Tension is the lightest, least space demanding load to transmit. At altitude, the ConcordLift ™ will turn and bank in the normal manner. Close to the ground, yaw is controlled by variation of engine power, spoilers automatically compensate for the increased lift on the outside wing, so turns can be with the wings level. The drag of the rear auxiliary tandem wing aids in yaw control. The auxiliary tandem wings control the pitch of the cargo wing. The center of lift is above the center of load.

E. Landing gear and operation for landing and take off

There are two separate types of gear. In addition to the normal main gear, there is a second set of "stabilizing gear". The closer the cargo wing is to the ground the greater is the danger of instability.

At take off, the auxiliary tandem wings rotate for maximum lift. The ConcordLift ™ lifts off from the main gear while the large diameter wheels of the stabilizing gear are still in contact with the runway. The aircraft finally leaves ground with the cargo wing already high above the runway.

On landing first contact with the ground is made by the stabilizing gear. They carry a portion of the total load while the rest of the load is still carried by the lift. They stabilize the craft while it is controlled to descend to the main gear. The main gear is of standard design.

Each 300 ft. section has 4 sets of 4 large diameter stabilizing wheels and main gear in sets of 4. The 450,000 lb. load could be supported by as many as 56 wheels for unimproved airfields.

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[2] https://www.drewry.co.uk/supply-chain-advisors/supply-chain-expertise/world-container-index-assessed-by-drewry. Most other routes have higher rates. This is one of the most competitive routes in the world.

[3] https://www.panynj.gov/port/en/shipping/containers.html.

F. Ground handling

Each 300 ft. section has latches to join the sections on the ground for flight. Each section has its own control cab and can move under its own power. Motors pivot the stabilizing gear for direction and motors on the wheels power movement. Sections can travel end on. The main gear casters as needed. No ground tugs are necessary. Few ground routes would be needed so automatic trackways could be used. The sections would travel to fixed loading places. With only 15 TEU per channel, unloading and reloading would be quick. The containers would travel to and from storage and the fixed loading equipment.

G. Engines

Since prop wash over the top of the wing increases lift, many electric engines might be an advantage.

On takeoff and landing, with the auxiliary wings set for maximum lift, the vector for drag will move higher. It may be necessary to mount some engines high on the front fins and auxiliary wing so the thrust vector matches the drag from the rear. A cable would transmit the force to the rear wing.

Flights may last several days. Heavy, fuel efficient engines, could make for less total weight. The sponsons between the stabilizing gear could have railroad diesel electric sets. The great wing surface could be covered with solar panel arrays.

H. Laminar-flow control

The great cargo wing surface create high drag from boundary layer air. A historic solution, reducing drag by 30%[4], was to perforate the wing surface, draw the boundary layer inside, and exhaust it. That has been impractical to implement for existing aircraft. It is practical on this aircraft. The cargo wing interior is empty except for the container channel. The exhausted air produces thrust enhancing efficiency.

I. Crew, Flight deck

Long distance flights will take several days. Provision is made to house for relief crew. Automatic flight management control is intended to manage the multiple flight control surfaces in normal flight. Automated landing and take off is also intended and is current state of the art for aircraft.

Storms move faster than ships and overtake, sink ocean ships. ConcordLift™ is faster than storms. Weather forecasting should prevent ConcordLift™ from ever being flown into dangerous weather. If they were on the ground they could fly away from approaching typhoons.

J. Construction

Slow, low, unpressurized, repeated basic shapes mean fast, low cost, light weight, simple construction. ConcordLift™ could be fabric covered space frames. Simple jigs could shape 10 foot elements for the cargo wing pod, forming a section a day. ConcordLift ™ could be constructed with 1940's technology.

K. Conclusion

There are no papers, or prior art, to reference that would increase understanding. The name for this configuration is "ConcordLift™", because the wings work in concord – harmony. Research will correct, modify or disprove the concept. It has great commercial potential. Since it is unique, existing engineering principles and wind tunnel data may not be adequate. Even when placed in operation, second and third generation aircraft should show further improvement.

L. Additional material for the Presentation

The paper is the result of the thought experiment. The thought processes of the experiment that led to the configuration are described in the Power Point presentation. Multiple conflicting issues are resolved sequentially and result in the unique configuration. Illustrations of different types of sections are shown. The complex interactions of landing gear and auxiliary wings that enable ConcordLift ™ to take off and fly are shown in the animation.

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[4] *Chambers, J.R., Innovation in Flight Research of the NASA Langley Research Center on Revolutionary Advance Concepts for Aeronautics,* NASA SP-2005-4539, p.126.