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# COLD CHAIN VISIBILITY AND INTEGRITY
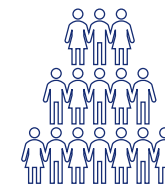
Martin Meckesheimer, Ph.D.
Director, Analytics and Innovation
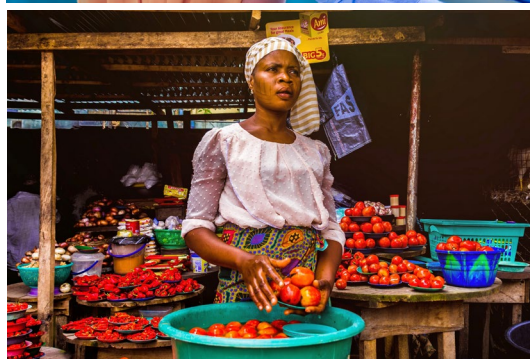
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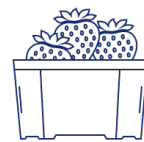
While the world produces enough food to feed **10 billion** people, **1/3** or more is wasted every year

**800 million** people go hungry every day

Food waste results in an estimated **4.4 gigatons** of greenhouse gas emissions

If food wastage were a country, it would be the **3rd** largest emitting country in the world

**13%** of food in the world is lost due to a lack of refrigeration

Source: Intelligent, Connected and Sustainable – Defining the Smart Cold Chain, A Primer (2018)

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# Main Links of a Cold Chain
# Example: South America to Europe



**Farm**

**1st Link**

**Receiver**

**Distribution Center**

**Supermarket**

**3rd Link**

**2nd Link**

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# Factors That Affect Transport Quality

**Product**



**Trailer / Container Preparation**



**Loading**

Optimal Air Flow



Off-wall Loaded

Wall Loaded
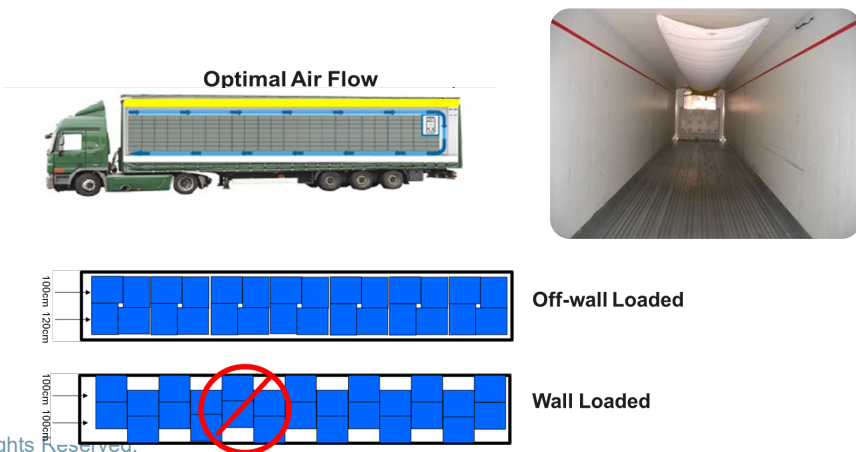
**External Conditions**

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# Why Maintain Good Handling Practices During the Cold Chain?



Stored **7 days** at **2.5°C**
and **12 hours** at **20°C**



Stored **7 days** at **5.0°C**
and **12 hours** at **20°C**

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5 Key
Attributes

- ☑ Delighted customers
- ⚡ Reduced energy use and GHGs
- 🌡 Improved cold chain performance
- 🍌 Minimized food waste
- ⊕ Optimized food quality and safety

The Smart Cold Chain

# DIGITAL TWINS
# VIRTUAL CARGO MONITORING

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# End-to-end visibility and leveraging advanced data analytics for control

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Data analytics advancement is essential to providing visibility and control of the cold and supply chains.

| Capture | → | React | → | Transform | → | Act | → | Anticipate |
|---------|---|-------|---|-----------|---|-----|---|------------|

**Capture**

Collecting data and information from end-to-end is the critical first step

**React**

Incorporating the data into operations to drive business improvements retrospectively with KPIs

**Transform**

Aggregating data, bringing together related information to create a dimensional view of the supply and cold chain ecosystems and its participants
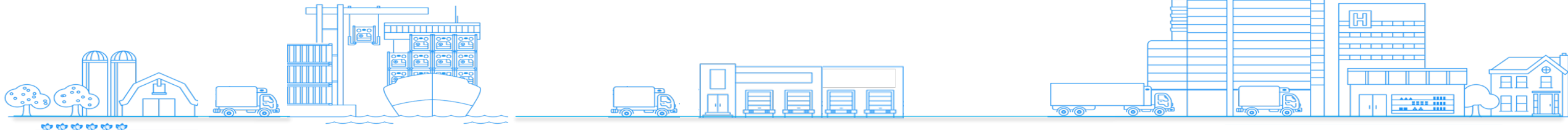
**Act**

Speeding the timeliness of data into real-time provides a greater ability to make decisions to divert or reduce issues

**Anticipate**

Predictive analytics and digital twins provide the ability to anticipate and virtualize what may happen before it happens

# Digital twins in cargo monitoring

## Real-time supply chain and cold chain cargo monitoring is ideal for digital twin models

Digital twins are enabled by leveraging:

- ○ High volume IoT data capture
- ○ Easy delivery of data
- ○ Mathematical and physics models
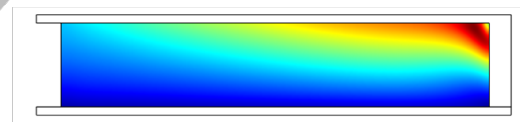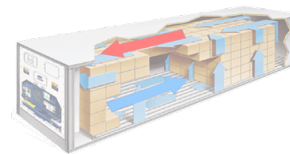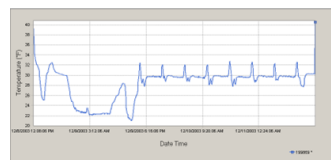- ○ Advanced analytics to develop predictive models

**INPUTS**
- Air temperature
- Relative humidity
- Air flow
- Fruit properties
- Packaging

**Digital Twin**

Time=21600 s · Temperature (degC)
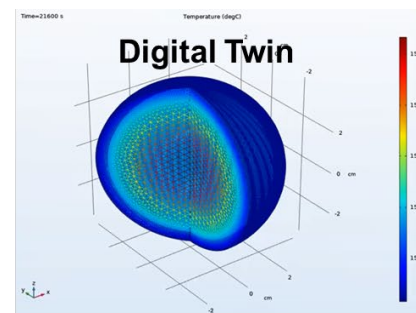
**OUTPUTS**
- Temperature anywhere in the fruit
- Weight loss
- Fruit condition
- Remaining postharvest life

Better understanding of thermal behavior allows more effective recommendations for improvement

=

1. Reduced product loss
2. Higher quality
3. Better compliance

Refrigerated Marine Container Side View

Estimated temperature throughout container based on model.

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# Enhanced cold chain monitoring of produce

Over 26 types of produce have already been modeled.

**Nightshade & Others**
Bitter Gourd
Bell Pepper
Cucumber
Eggplant
Tomato

**Leafy Greens**
Coriander

**Cruciferous**
Cabbage
Cauliflower
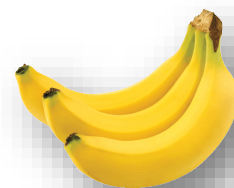
**Fruits**
Apples
Bananas
Guava
Mango
Melon
Peaches
Pears
Plantain

**Beans**
Peas
Green Beans
Okra

**Citrus**
Oranges
Lemons

**Berries**
Grapes
Strawberries
Raspberries
Blueberries

**Root Vegetables**
Potatoes
Cassava
Carrots

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# Improve visibility of pallet conditions

Understand how the shipment's container impacts key metrics of the product condition.

**Quality Managers** can get a better understanding of the impact on the products based on environmental conditions captured by a single IoT device.

Digital twins can provide key information to help make decisions about how the product should continue through the supply chain:

o **Minimum Remaining Shelf-life** to help understand if product should be accepted or rejected

o Assess **Maximum Mass Loss** that shipment conditions have had on the products

o **Core product temperature** predictions through virtual probes

o Identification of **hot and cold spots** in the cargo to show problematic regions in the trailer and direct targeted samplings

The gain for the Quality Team is visibility into a single fruit without destructive testing – saving time, labor and reducing product loss.

# Gain resilient inventory management

Digital twins can help provide better decision-making and resiliency around inventory.



**Operations Managers** can enhance the information they use to make decisions around managing products and inventory.

o Reducing food loss at operations or downstream by prioritizing products based on remaining shelf-life predictions

o Building resiliency into the business through proactively managing perishable products

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# Explore improvement virtually

Through digital twin models 'what if' scenarios can be explored to quickly deliver improvements in operations.

Instead of costly real-world projects to drive improvements, digital twin models allow for exploring what changes could improve the key metrics of Remaining Shelf-Life, Mass Loss and Core Product Temperature.

The 'what if' scenarios can include:

o Loading patterns of trailers

o Variations by trailer characteristics

o Adjustment to pre-cooling protocols

o Pre-cooling scenarios

These scenarios allow collaboration with **Supply Chain Partners** to help deliver improvement.

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# How do bring virtual data into to your operations and benefit from it

Data can be delivered for real-time operations decisions or as analytics for deeper business changes.

### Alerts & Notifications

Proactively manage incoming products through alerts and notifications and gain a deeper insight into product conditions as they arrive.

### Reports & Analytical Dashboards

Understand trends better to help make better business decisions and save time and money.

### Integrations

Deliver the data where and how you need it, incorporating the information into your business operations.

**Expand visibility**

**Speed up decision-making**

**Deliver agile and resilient operations**

**Save time and labor**

# Q&A

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