

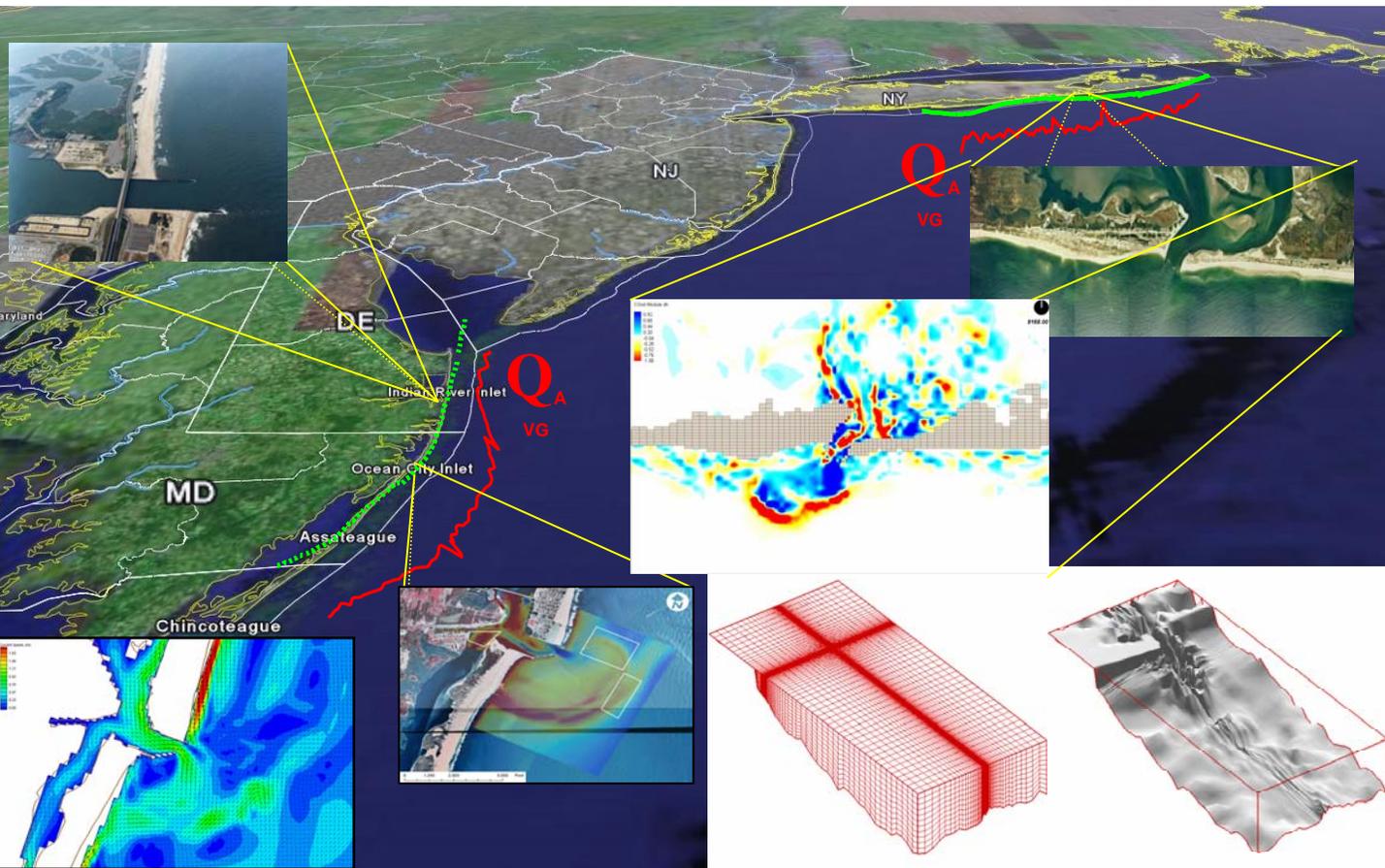


# Coastal Inlets Research Program and System-Wide Water Resources Program



## 7<sup>th</sup> Annual Technology-Transfer Workshop

# Numerical Modeling of Hydrodynamics and Sediment Transport at Coastal Inlets, Navigation Channels, and on Regional Scale



In cooperation with  
**National Conference on  
Beach Preservation Technology**  
January 30-February 1, 2006, Sarasota, FL



US Army Corps  
of Engineers

## Session B



**Numerical Modeling of Hydrodynamics and Sediment Transport  
at Coastal Inlets, Navigation Channels, and on Regional Scale**

**U.S. Army Corps of Engineers**

**Coastal Inlets Research Program and System-Wide Water Resources Program**

*7th Annual Technology-Transfer Workshop*

**January 30 – February 1, 2006, Sarasota Hyatt on Sarasota Bay, Sarasota, Florida**

**In cooperation with**

**Florida Shore and Beach Preservation Association**

**National Conference on Beach Preservation Technology, February 1-3, 2006**

**Monday, January 30, 2006**

	<b>Session A</b> (limited to 12 PCs, 24 attendees total) <b>Inlet Modeling System (IMS)</b>	<b>Session B</b> (limited to 30 attendees total) <b>Inlet and Regional Coastal Management</b>
8:00 - 8:30	Registration, Welcome (load software)	Registration, Welcome (load software) ArcView w/Image Analyst necessary for BeachTools and INLETGIS sessions
8:30 – 9:30	<u>Session A &amp; B: Overview:</u> Progression of CIRP-Inlet Modeling System (IMS) Workshops Session topics, outline, and expectations overview of technology and near future plans (Connell & Lin)	
9:30 – 9:50	<b>Break</b>	
9:50 – 10:30	<u>Lecture:</u> IMS-M2D capabilities: Morphology Change and Beyond (Connell)	<u>Lecture:</u> Sediment Budget Analysis System - SBAS (Rosati)
10:30 - 12:00	<u>Finite-Difference Grid Generation:</u> Bathymetry sources Aerial photography Coastline extraction/revision Grid generation methods Grid refinement/adjustment (Brown)	<u>Hands on Session:</u> Sediment Budget Analysis System - SBAS (Rosati)
12:00 - 1:00 pm	<b>Lunch</b>	
1:00 - 2:00	<u>Lecture:</u> Nearshore Wave Modeling at Inlets IMS-Wave Model Theory, M2D-wave Hydrodynamic Steering (Lin)	<u>Lecture:</u> Regional Morphology Analysis Package- RMAP (Morang)
2:00 - 3:00	<u>Model Options and Parameters:</u> Hydrodynamic Options Timing Parameters Output Options Hot Start Options <u>Model Forcing:</u> Boundary Forcing Surface Forcing (or Wind Forcing) Wave Forcing (Brown & Lin)	<u>Case Studies and Hands-On Session:</u> Regional Morphology Analysis Package (RMAP) (Morang)
3:00 – 3:30	<b>Break</b>	
3:30 – 5:00	<u>Simulation &amp; Post-Processing:</u> <u>Global results:</u> Water surface elevation and velocity Contour and vector plots Animations <u>Single point results:</u> Time series plots (Brown & Lin)	<u>Hands-On Session:</u> Hands-on practice with RMAP and SBAS; questions, discussion (Morang & Rosati)
5:00	<b>Adjourn</b>	

**Tuesday, January 31, 2006**

	<b>Session A Inlet Modeling System (IMS)</b>	<b>Session B Inlet and Regional Coastal Management</b>
8:00- 9:00	<u>Lecture:</u> IMS-M2D Sediment Transport and Morphology Change (Ono)	<u>Lecture:</u> Inlet Reservoir Model, Introduction (Dabees)
9:00 – 10:00	<u>Case Studies and Hands-On Session:</u> IMS-M2D Sediment Transport and Morphology Change (Reed & Ono)	<u>Case Studies and Hands on Session:</u> Inlet Reservoir Model (Dabees)
10:00 - 10:15	<b>Break</b>	
10:15 - 11:00	<u>Case Studies and Hands-On Session:</u> IMS-M2D Sediment Transport and Morphology Change (Reed)	<u>Lecture:</u> Cascade – a new regional sediment transport model for project management & engineering (Connell)
11:00 - 12:00	<u>Lecture:</u> IMS-M3D capabilities: present and near future M2D vs. M3D: Why, Where, & When to use M3D (Reed)	<u>Hands-On Session:</u> Cascade Input data sources and model setup (Connell)
12:00 - 1:00	<b>Lunch</b>	
1:00 - 2:00	<u>3-D Grid Generation and Model Options:</u> IMS-M3D 3-D grid generation, boundary Conditions, and model parameters (Reed)	<u>Case Studies and Hands-On Session:</u> Cascade (Connell)
2:00 - 3:00	<u>Lecture:</u> IMS-M3D Sediment Transport Implementation and Morphology Change (Reed)	<u>Lecture:</u> BeachTools and INLETGIS: GIS Toolbox for quantifying morphology change at inlets (Zarillo)
3:00 - 3:15	<b>Break</b>	
3:15 – 4:00	<u>Case Studies and Hands-On Session:</u> IMS-M3D Case: idealized inlet (Reed & Rosati)	<u>Hands-On Session:</u> BeachTools and INLETGIS (Zarillo)
4:00 - 5:00	<u>Hands-On Session:</u> IMS-M3D w/Channel Infilling (Reed & Rosati)	<u>Hands-On Session:</u> BeachTools and INLETGIS (Zarillo)
5:00	<b>Adjourn</b>	

**Wednesday, February 1, 2006**

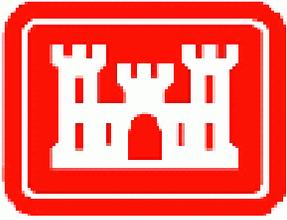
	<b>Session A</b> <b>Inlet Modeling System (IMS)</b>	<b>Session B</b> <b>Inlet and Regional Coastal Management</b>
8:00- 9:30	<u>Hands-On Session:</u> IMS-M2D Long-term Morphologic Steering w/ Hard Bottom Case: Sebastian Inlet (Zarillo)	<u>Hands-on Practice, all technology</u> (optional)
9:30 - 10:00	<u>Lecture:</u> Overview of CIRP website Inlets Online (Connell)	
10:00 – 10:30	<b>Break</b>	
10:30 – 11:30	<u>M2/3D Future Developments Preview:</u> Implicit Solution Scheme, telescoping grid, and other features planned for IMS-M2/3D (Reed)	<u>Hands-on Practice, all technology</u> (optional)
11:30-12:00	Evaluation	
12:00	<b>Adjourn</b>	

**Workshop Instructors**

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**<http://cirp.wes.army.mil/cirp/cirp.html>**

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# Welcome!



## U.S. Army Corps of Engineers Coastal Inlets Research Program and System-Wide Water Resources Program

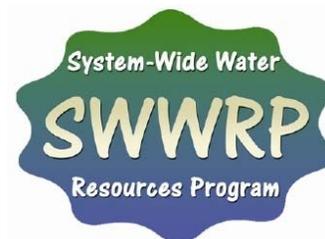
### 7<sup>th</sup> Annual Technology-Transfer Workshop

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# Coastal Inlets Research Program

*...advancing inlet science and engineering*



**Developing predictive technology and engineering guidance to address:**

- **Advance maintenance dredging**
- **Channel widening, deepening**
- **Jetty modification**
- **Channel reliability**
- **Scour reduction**
- **Bypassing to adjacent beaches**
- **Ebb & flood shoal mining**
- **Efficiency of engineering studies**



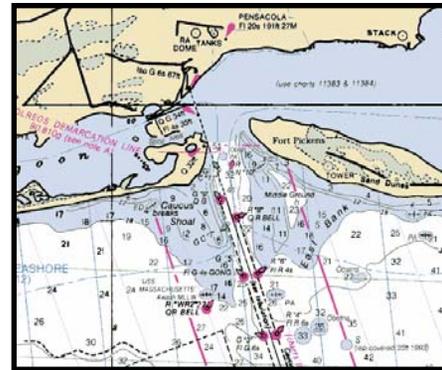
**Packery Channel, TX,  
under Federal construction  
2005-2006,  
based in part on CIRP technology**

# CIRP Objectives

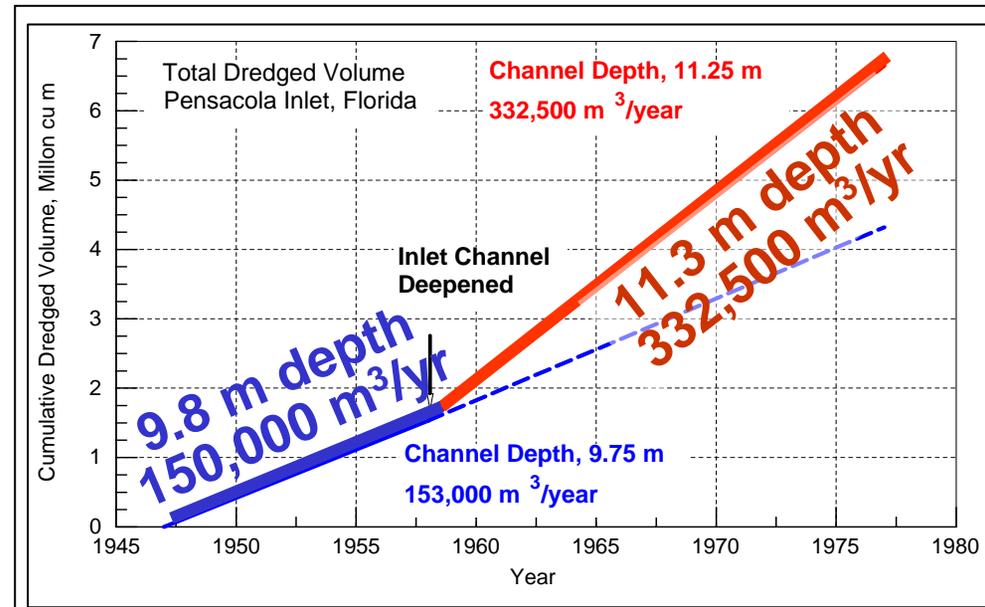


- Conduct R&D to reduce O&M costs at inlet navigation projects.
- Treat inlet channels & adjacent beaches as a system.
- Transfer technology.
  - Guidance documents, Workshops
  - Engineering models, Web site,
  - Advanced models, PC software

Deepening a channel can greatly increase dredging requirements; need to predict this.



Pensacola Pass, FL



# Federal Coastal Inlets

~ 150 major inlets

~ 500 total inlet & harbor channels



# Coastal Inlet Navigation Channel O&M



The Corps moves  
250-350 Million cu yd of sediment annually



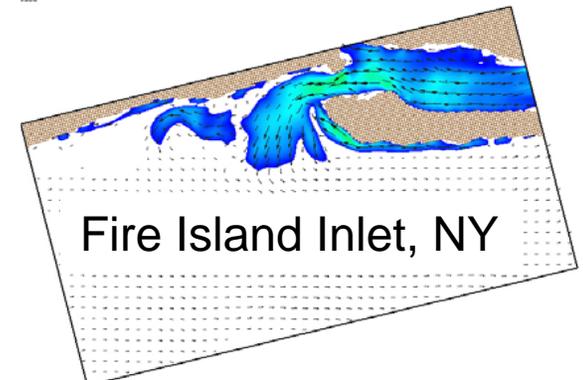
**Costing > \$800 Million per year**

# Our Vision

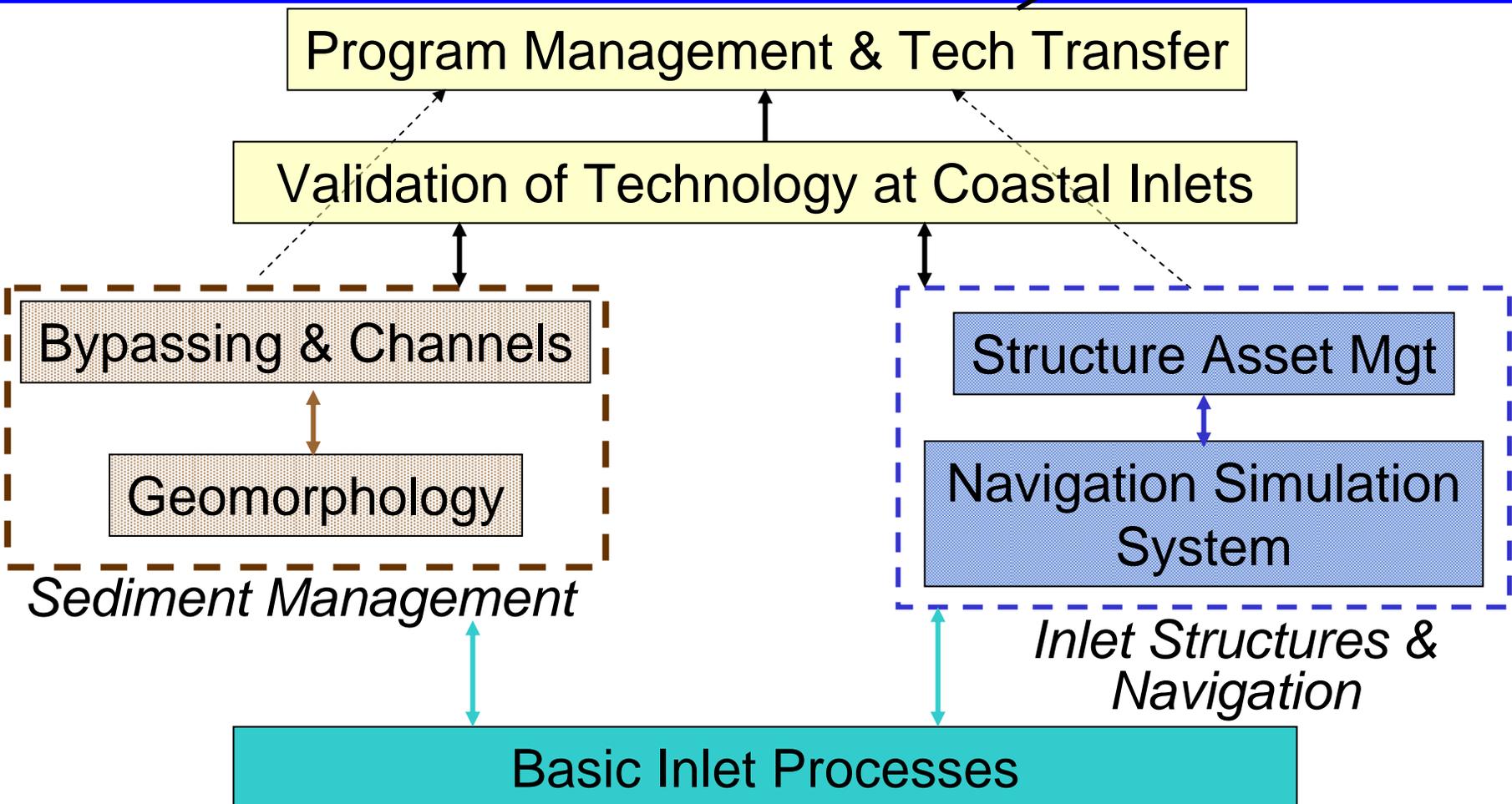
*CIRP....advancing inlet science and engineering*



- District engineers and scientists run CIRP desk-top models
  - Reconnaissance-, feasibility-, and design-level O&M projects
  - Inlet channels, shoals, structures, and adjacent beaches
  - Short-term (storm cycles) to long-term (project life) analyses
- Web-based databases, tools, and downloads
  - Rapid access to integrated knowledge and guidance
- Advance predictive technology for inlets, structures, & adjacent beaches

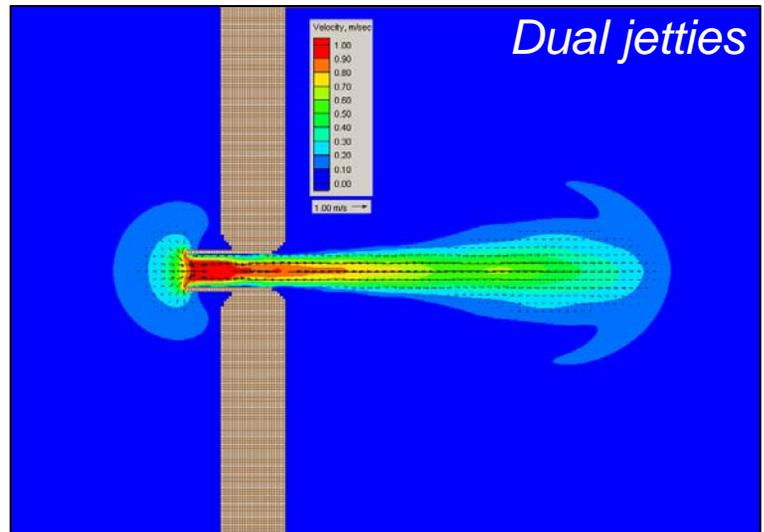
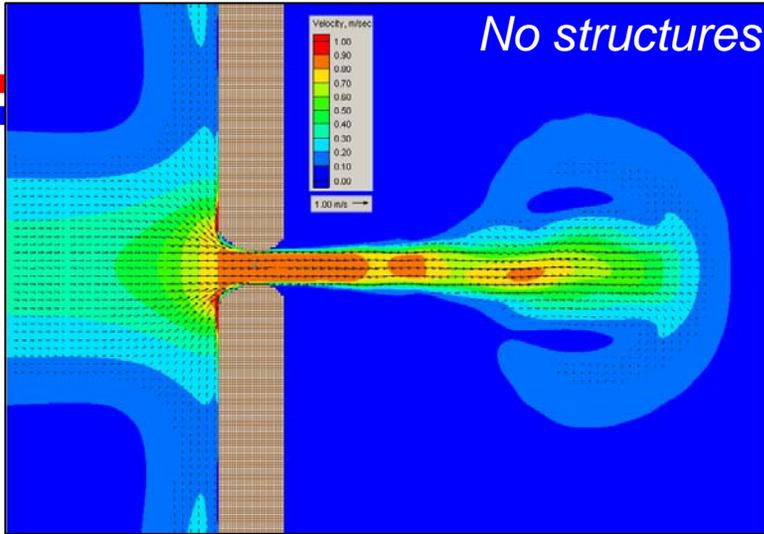


# CIRP—Seven work units



# WU 1. Basic Inlet Processes

Lihwa Lin



Need: Improve processes integral to modeling waves, currents, and sediment transport at inlets.

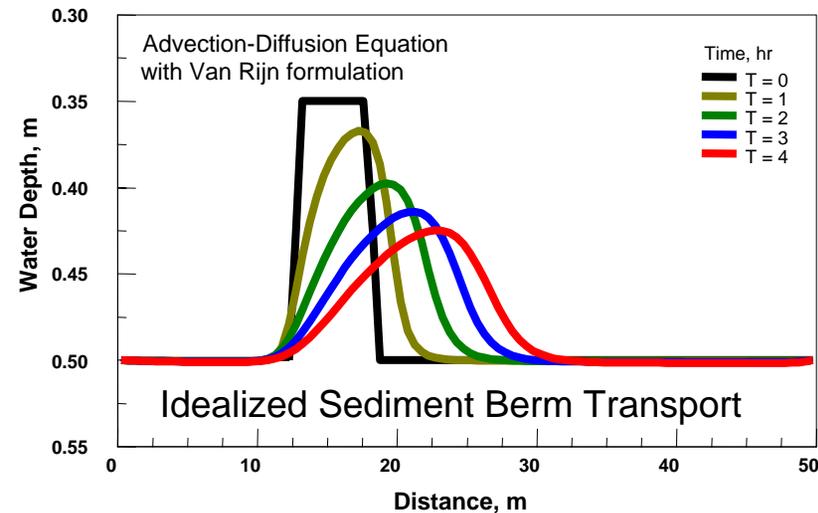
Approach: Individually evaluate and improve modeling components –

- Wave diffraction.
- Wave breaking over shoals.
- Sediment transport at inlets.

Evaluating Tidal Flow for Unstructured and Jettied Inlets

# WU 2. Inlet Bypassing & Nearshore Berms

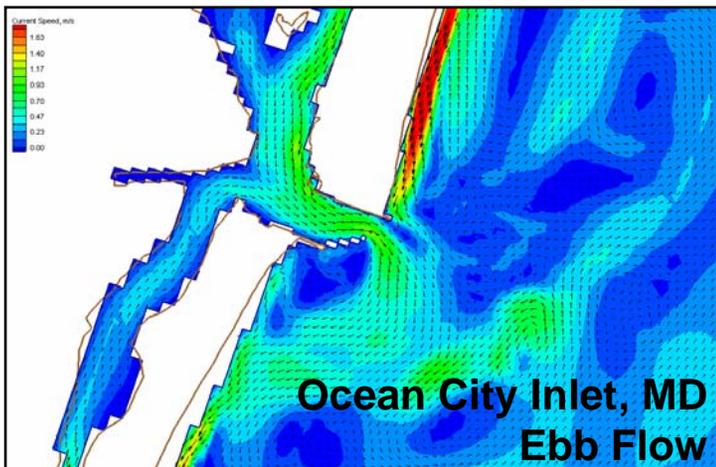
## Nicholas Kraus



Need: Predictive technology to treat inlet channels & adjacent beaches as a sand-sharing system.

Approach: Develop **Inlet Modeling System (IMS)** to address:

- Channel infilling & design.
- Bypassing.
- Nearshore berm performance as a disposal option.
- Navigation reliability.
- Integrated inlet processes.



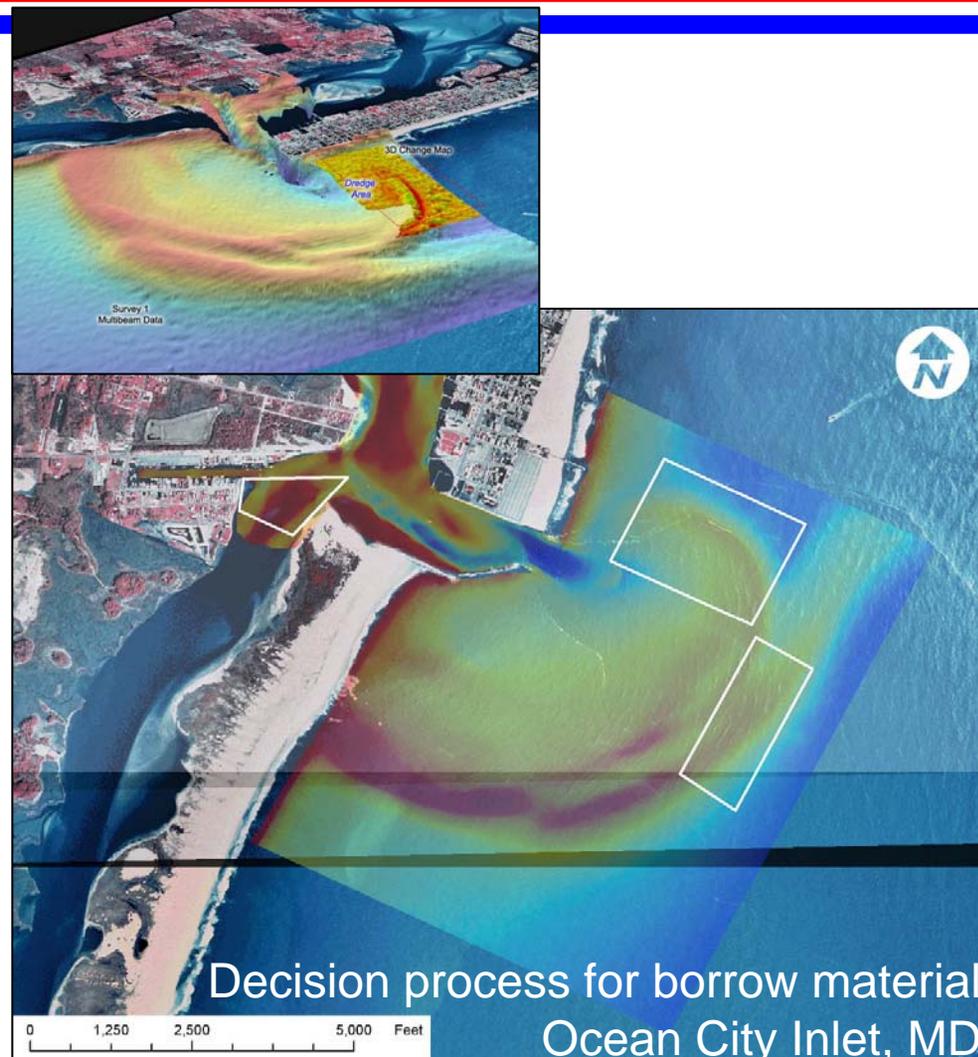
# WU 3. Inlet Geomorphic Evolution

Ken Connell



Need: Many Federal inlets > 100 years old, and morphology has greatly changed. Inlet modifications will permanently change coastal morphology, & O&M will be carried out with that morphology.

Approach: Develop tools and guidance to predict morphologic evolution due to O&M over long temporal and spatial scales.



# WU 4. Validation of Predictive Technology

Julie Rosati



Matagorda Ship Channel, TX

Need: Validate CIRP models and tools at reconnaissance, feasibility, and design-levels. Solve O&M problems common to Corps projects.

Approach:

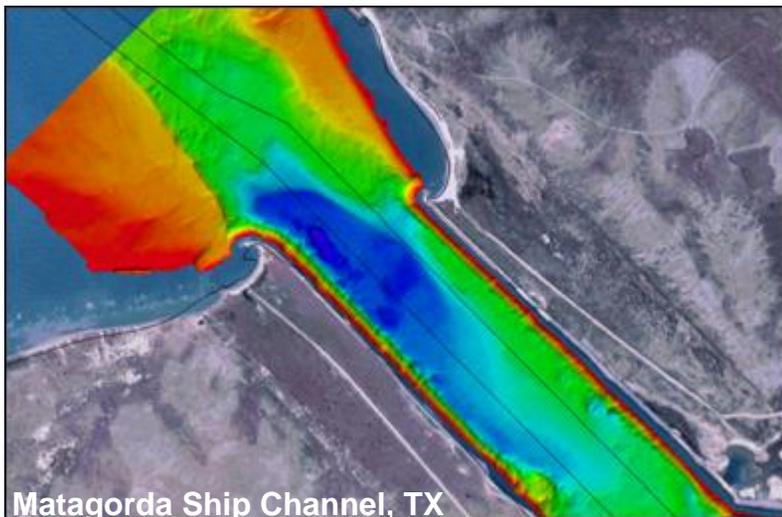
- Test CIRP's emerging technology at sites with critical District O&M concerns of broad applicability.
- Propose and evaluate solutions.
- Develop web-based decision-support tools for O&M actions and anticipated response.

# WU 5. Coastal Structure Asset Management

Steve Hughes, Jeff Melby



Need: Procedure to make objective evaluation and prioritization of O&M funding for repair, rehabilitation, and maintenance of critical coastal navigation infrastructure.



Matagorda Ship Channel, TX

Approach: Update coastal structure design guidance and develop new procedures for using the guidance within the Asset Management Decision Tool – AMDT -- framework.

# WU 6. Navigation Simulation System

## -- Zeki Demirbilek



Need: lack processes required for accurate prediction of wave-structure and wave-ship interactions.

Approach – improve modeling:

- Detailed wave transformation at inlets.
- Wave, current, & structure interaction.
- Wave runup & overtopping of coastal structures.
- Vessel-induced wakes & currents.
- Vessel & channel interaction.



# WU 7. Program Management and Technology-Transfer

## -- Nicholas Kraus



Need: Coastal Inlet Research Program objectives to reciprocate the USACE mission.

Approach – get R&D into the field:

- Asses the applicability of research to O&M goals.
- Desktop-based modeling tools.
- Web-based support.
- Guidance documents, workshops, and training



ERDC Technical Director:  
CIRP Program Manager:

Jim Clausner  
Nick Kraus

# CIRP—Accomplishments



- Inlet Modeling System (IMS) – available via SMS
- Sediment Budget Analysis System (SBAS) with SWWRP co-funding
- Inlet Reservoir Model for Sediment Bypassing
- Particle Tracking Model (PTM) – jointly funded with DOER
- Field data sets and laboratory data sets for validating technology
- Breaching model – breaching near inlet jetties
- Fundamental advances in understanding inlet stability, scour at jetties, coastal structure design
- More than 20 technology-transfer workshops
- Applications in support of difficult District problems
- CIRP website, online tools and guidance, downloads



# CIRP Website



# http://cirp.wes.army.mil/cirp/

## Website Objectives:

- Information about CIRP
- Technology Transfer
- Simple Online Tools
- Easy Site Navigation

## Information:

- CIRP Research
- Upcoming Events
- Past Presentations
- Photo Collections

## Publications:

- CHETNs
- Technical Reports
- Journal Articles
- Conference Papers



# System-Wide Water Resources Program (SWWRP)



- Multi-laboratory collaboration
- Support system-wide approach to planning, engineering, operations, and management
  - Regional water resource management
  - Regional sediment management
  - Ecosystem assessment and management
- Prediction of project interaction with environment on regional spatial scales, and long-term temporal scales, while recognizing the importance of project-level analysis for local effects

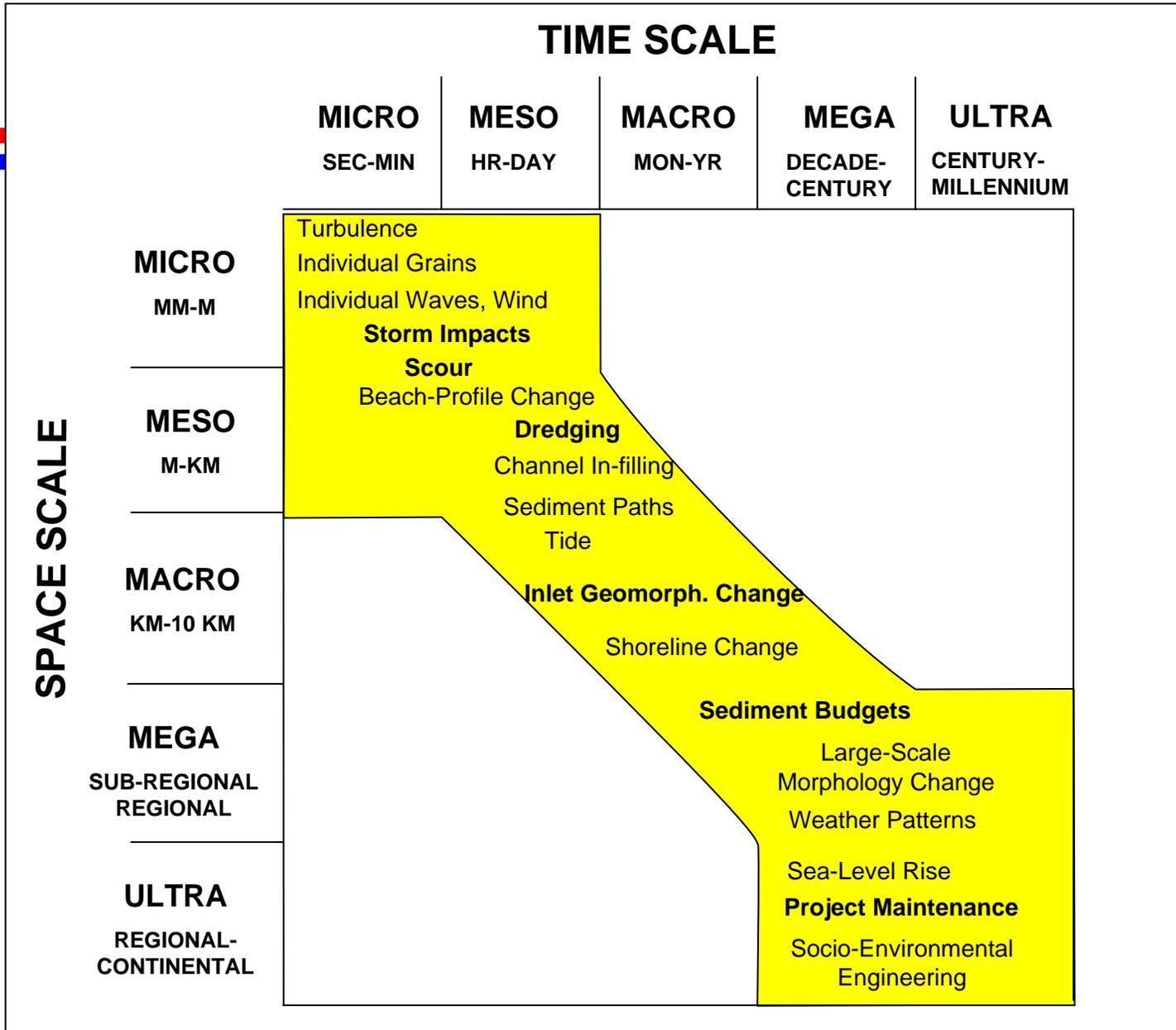
# Primary SWWRP objectives



- Common software infrastructure
  - Data
  - GIS tools
  - Modeling tools
  - Analysis tools
- Suite of integrated system-wide assessment models:
  - Watershed hydrology
  - Long waves
  - Coastal environments
  - Water quality
  - Sediment and contaminant transport
  - Ecological response
- Web-based support



# Approach to time and space scales





# Products

## Cascade and Data Analysis Toolboxes

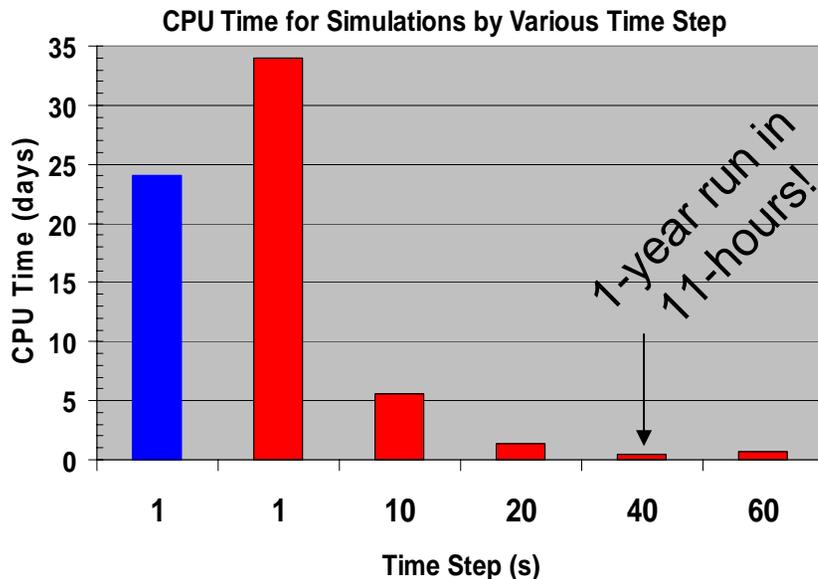
- **Cascade** – Regional model of project-scale to long-term coastal morphology evolution, incorporating new concepts and technology.
- **RMAP** – Regional Morphology Analysis Package Stand-alone GIS-based spatial data analysis toolbox .
- **SBAS** – Sediment Budget Analysis System (stand-alone on PC and also in ArcView GIS).

# Near Future Developments



- IMS
  - Implicit Numerical Scheme
  - Telescoping grids
  - Improved structure handling

- Cascade
  - Crossshore processes
  - Barrier island breaching model
  - Barrier island consolidation model
  - Habitat models
- RMAP
  - Relational database
  - Improved efficiency (architecture)
  - 3D eigenfunctions



# Workshop Session A: Inlet Modeling System (IMS)



## Monday, January 30

9:50 – 10:30	<u>Lecture:</u> IMS-M2D capabilities: Morphology Change and Beyond (Connell)
10:30 - 12:00	<u>Finite-Difference Grid Generation:</u> Bathymetry sources Aerial photography Coastline extraction/revision Grid generation methods Grid refinement/adjustment (Brown)
1:00 - 2:00	<u>Lecture:</u> Nearshore Wave Modeling at Inlets IMS-Wave Model Theory, M2D-wave Hydrodynamic Steering (Lin)
2:00 - 3:00	<u>Model Options and Parameters:</u> Hydrodynamic Options Timing Parameters Output Options Hot Start Options <u>Model Forcing:</u> Boundary Forcing Surface Forcing (or Wind Forcing) Wave Forcing (Brown & Lin)
3:30 – 5:00	<u>Simulation &amp; Post-Processing:</u> <u>Global results:</u> Water surface elevation and velocity Contour and vector plots Animations <u>Single point results:</u> Time series plots (Brown & Lin)

## Tuesday, January 31

8:00- 9:00	<u>Lecture:</u> IMS-M2D Sediment Transport and Morphology Change (Ono)
9:00 – 10:00	<u>Case Studies and Hands-On Session:</u> IMS-M2D Sediment Transport and Morphology Change (Reed & Ono)
10:15 - 11:00	<u>Case Studies and Hands-On Session:</u> IMS-M2D Sediment Transport and Morphology Change (Reed)
11:00 - 12:00	<u>Lecture:</u> IMS-M3D capabilities: present and near future M2D vs. M3D: Why, Where, & When to use M3D (Reed)
1:00 - 2:00	<u>3-D Grid Generation and Model Options:</u> IMS-M3D 3-D grid generation, boundary Conditions, and model parameters (Reed)
2:00 - 3:00	<u>Lecture:</u> IMS-M3D Sediment Transport Implementation and Morphology Change (Reed)
3:15 – 4:00	<u>Case Studies and Hands-On Session:</u> IMS-M3D Case: idealized inlet (Reed & Rosati)
4:00 - 5:00	<u>Hands-On Session:</u> IMS-M3D w/Channel Infilling (Reed & Rosati)

# Workshop Session A: Inlet Modeling System (IMS)



## Wednesday, February 1

8:00- 9:30	<a href="#">Hands-On Session:</a> IMS-M2D Long-term Morphologic Steering w/ Hard Bottom Case: Sebastian Inlet (Zarillo)
9:30 - 10:00	<a href="#">Lecture:</a> Overview of CIRP website Inlets Online (Connell)
10:30 – 11:30	<a href="#">M2/3D Future Developments Preview:</a> Implicit Solution Scheme, telescoping grid, and other features planned for IMS-M2/3D (Reed)

# Workshop Session B: Inlet and Regional Coastal Management



## Monday, January 30

9:50 – 10:30	<u>Lecture:</u> Sediment Budget Analysis System - SBAS (Rosati)
10:30 - 12:00	<u>Hands on Session:</u> Sediment Budget Analysis System - SBAS (Rosati)
1:00 - 2:00	<u>Lecture:</u> Regional Morphology Analysis Package- RMAP (Morang)
2:00 - 3:00	<u>Case Studies and Hands-On Session:</u> Regional Morphology Analysis Package (RMAP) (Morang)
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# Workshop Session B: Inlet and Regional Coastal Management



## Wednesday, February 1

8:00- 9:30	<a href="#">Hands-on Practice, all technology</a> (optional)
9:30 - 10:00	<u>Lecture:</u> Overview of CIRP website Inlets Online (Connell)
10:30 – 11:30	<a href="#">Hands-on Practice, all technology</a> (optional)

# Workshop Instructors



Mitch Brown..... USACE-CHL  
Ken Connell..... USACE-CHL  
Mohamed Dabees..... Humiston and Moore  
Lihwa Lin..... USACE-CHL  
Andy Morang..... USACE-CHL  
Nobuyuki Ono..... ECOH Corporation, Japan  
Chris Reed..... URS Corporation  
Julie Rosati..... USACE-CHL  
Gary Zarillo..... Florida Institute of Technology

<http://cirp.wes.army.mil/cirp/cirp.html>

Program Manager: Nick Kraus, Nicholas.C.Kraus@erdc.usace.army.mil, USACE-CHL

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