

Research & Development

Centro de Investigaciones Interdisciplinarias para la Industria
Marítima y Fluvial (CIII-MAF)



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Applied Research Philosophy

From Data to Design — From Design to Impact

CIII-MAF was born as a strategic initiative of ROMV-BMS to integrate advanced computational science, multiphysics simulation and applied artificial intelligence, at the service of naval, river and port innovation, supported by doctoral studies and its research group. CIII-MAF not only promotes scientific research, but also translates knowledge into real solutions for the sectors of design, construction, operation and maintenance of vessels, integrating scientific rigor and industrial vision, advanced modeling and multiphysics simulation, machine learning and artificial intelligence Systems, and, interdisciplinary collaboration between academia and industry



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Applied Research Philosophy

Philosophy

CIII-MAF, promoted by ROMV-BMS, was born as a strategic response to the challenge of integrating computational science with the real challenges of the naval, riverine and port industry in emerging environments. Their vision is clear: transform data into decisions, simulations into design, and models into intelligent solutions. Our philosophy is based on three pillars:

1. Scientific interdisciplinary + industrial vision: By combining naval engineering, data science and project management to create robust and applicable solutions.
2. Technological sovereignty + regional scalability: By prioritizing the implementation of on-premise solutions and the development of sustainable local capacities.
3. Innovation in context + real digital transformation: By applying artificial intelligence, advanced modeling, and cyber-physical systems to industrial processes, from design to operation.



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Scope of Work

Computational infrastructure and R+D services

CIII-MAF acts as an operational core for high-impact research and technological development initiatives. Our baseline includes:

- Development and training of AI models, deep learning, reinforcement learning, and LLMs (Large Language Models) and, development of deep learning, reinforcement and latent representations models applied to the design and operation of vessels
- Image and sensor signal processing for tourist, industrial and defence vessels
- Evaluation and prediction of energy efficiency in ship interior design (e.g., autoencoders and clustering on HSV space)
- Multiphysics simulation (CFD, FEM) for structural, hydrodynamic, and propulsion analysis
- Business intelligence and data mining on historical naval and river operations
- Regional naval power modeling (e.g., CINC and geopolitical clustering)
- Training of LLMs for contextualized technical assistance in maritime operations
- Integrating Digital Twins for Predictive Maintenance.

R+D APPLICATIONS

Based on the challenges and strategic assets of the shipyard, we propose the following doctoral lines within Applied Computational Sciences (CCA):

- Latent Rendering and Computer Vision: Semantic segmentation of ship interiors and exteriors; correlation with energy efficiency and comfort.
- Reinforcement Learning in Intelligent Controllers: Applied to piloting, trimming and adaptive power control in real and simulated navigation.
- Prediction and Simulation of Naval and Economic Power: Based on historical datasets such as the CINC, with unsupervised models (PCA, clustering, ARI).
- Optimizing Naval Projects with Generative Models: Automatic generation of WBS, Project Charters, and 3D views from metadata and images.
- Human-Machine Interaction in Digital Shipyards: Intelligent interfaces for assisted design, predictive maintenance, and technical support.
- Digital Twins and Multimodal Fleet Operations: Integration of sensors, historical data and simulators for real-time decisions.

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Facilities and Capabilities

High Performance Computing & Secure Access

CIII-MAF has an expanding infrastructure for on-premise computing that allows the comprehensive approach to complex problems through:

- 1. Development and training of AI, deep learning, reinforcement learning, and LLMs (Large Language Models) models
- 2. Multiphysics simulation (CFD, FEM) applied to naval design
- 3. Modeling port and river operations using cyber-physical systems
- 4. Design and testing of intelligent controllers for boats (PID, RL-based, etc.)
- 5. Data integration into digital twins and embedded systems analytics
- 6. Generation of synthetic datasets and pipelines for machine learning.

Computational Capabilities for Research Options	Details
Workstation avanzada: 1 servidor torre (ej. chasis workstation) con CPU 16–32 cores (p. ej. Intel Xeon W or AMD Threadripper), 64–128 GB RAM , 2 GPUs (p. ej. 2× NVIDIA RTX 4090 o 2× RTX A5000 24GB), 2 TB SSD NVMe. Incluye periféricos básicos.	Capacidad: ~2 GPUs de ~20-35 TFLOPS cada una. Adecuado para desarrollo y ejecuciones medianas. Ventajas: Bajo costo inicial, movilidad (es una sola máquina). Limitaciones: Sin redundancia; si un componente falla, todo el nodo queda fuera. Escalable agregando GPUs externas limitadamente (máximo 2–4 GPUs según motherboard). Puede apoyarse en la nube para picos que excedan su capacidad.
Workstation de alto rendimiento: 1 torre con CPU AMD Threadripper Pro 32 cores, 128 GB RAM ECC, 2× NVIDIA RTX A6000 48GB, 2 TB SSD NVMe, UPS básico, refrigeración silenciosa.	Estación de trabajo potente orientada a entrenamiento de modelos de deep learning medianos y simulaciones de complejidad intermedia. Capacidad de operar 24/7. Ideal para I+D inicial sin saturar recursos cloud. Escalable con agregación de más GPU o conexión a NAS.
Nodo GPU dual y almacenamiento dedicado: 1 servidor en rack con dual CPU Intel Xeon 24 cores, 4× GPUs NVIDIA RTX 6000 Ada (48GB), 256 GB RAM ECC, 10 TB NAS compartido, switch 10GbE, UPS rackeable.	Capacidad media para cargas IA de múltiples usuarios. Suficiente para desarrollar LLMs de tamaño medio y ejecutar inferencia acelerada. Almacenamiento compartido permite centralizar datasets. Rack preparado para expansión futura. VPN y usuarios múltiples habilitados.
Cluster pequeño híbrido: 1 rack 18U con 2 nodos GPU y 1 nodo CPU + storage. Cada nodo GPU: dual CPU 32 cores c/u	Capacidad: 8 GPUs de alto rendimiento en total + 128 cores CPU. Permite entrenar varios modelos a la vez o uno grande distribuido (NVLink entre GPUs de cada nodo), y correr

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(total 64 cores) + 4× GPUs NVIDIA A100 40GB (o equivalentes) + 256 GB RAM. Nodo CPU: dual CPU 64 cores (128 cores totales) + 512 GB RAM, sin GPU, optimizado para CFD. Almacenamiento NAS: 20 TB útiles en RAID. Switch 10/40 GbE. UPS 5 kVA.	simulaciones multifísicos en paralelo en el nodo CPU. <i>Ventajas:</i> Alta potencia de cómputo on-premise, suficientes recursos para un grupo de investigación completo. Red 10/40GbE permite compartir datos rápidamente. <i>Limitaciones:</i> Expansión moderada (el rack podría añadir quizás 1 nodo GPU extra más adelante). La configuración considera GPUs Ampere; reemplazar por GPUs de última gen (H100) subiría el costo.
Cluster de 2 nodos GPU + nodo CPU HPC: 2 servidores GPU (dual AMD EPYC 64 cores + 4× NVIDIA A100 40GB c/u), 1 nodo CPU con 128 cores y 512 GB RAM, NAS 20 TB RAID, red 40 GbE, UPS 5 kVA, aire acondicionado dedicado.	Infraestructura robusta para ejecutar múltiples experimentos de entrenamiento profundo en paralelo, simulaciones CFD en paralelo y modelado estadístico pesado. Incluye control de colas y sistema de gestión de recursos (Slurm). Capacidad para 10+ usuarios concurrentes y acceso remoto seguro. Pensado para una mini unidad de HPC corporativa interna.
Centro de cómputo mini-HPC: 1 rack 42U con 4 nodos GPU y 2 nodos CPU interconectados. Nodos GPU: cada uno con dual CPU 32–64 cores + 4× GPUs NVIDIA A100/H100 (total 16 GPUs en cluster) + 512 GB RAM c/u. Nodos CPU: dual AMD EPYC 64-core (128 cores) c/u + 1 TB RAM para memoria intensiva. Red InfiniBand HDR 100Gb para baja latencia (o Ethernet 100Gb). Almacenamiento central: cabina 50 TB con SSD/NVMe tier + HDD tier. Sistema de gestión (head node) con herramientas de orquestación (Slurm, Kubernetes para AI). Cooling redundante (2× AC).	<i>Capacidad:</i> comparable a un NVIDIA DGX Station/SuperPOD de nivel básico (16 GPUs sumando ~>>5 petaFLOPS AI, y >250 CPU cores). Puede manejar entrenamiento de modelos muy grandes (incluso prototipos de GPT de billones de parámetros con paralelo de datos), y simulaciones HPC extensas. <i>Ventajas:</i> Infraestructura multi-usuario real, con cola de trabajos, aislada, capaz de atender proyectos concurrentes y algunos servicios externos. Alta redundancia (múltiples nodos: si uno falla, quedan otros; storage en RAID). <i>Consideraciones:</i> Requiere administración profesional activa. El consumo eléctrico es elevado; aprovechar al máximo la utilización es crucial para la rentabilidad. Es la opción más cercana a un centro de súper cómputo on-premise, con control total y sin dependencias de nube, pero con los costos y responsabilidades asociados.

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Our Team

Competencies Radar

We recognize that successful innovation in the maritime and riverine industry must be not only visionary, but also technically sound, data-driven, and computationally enabled. That is why our research-based mission is supported by a carefully integrated structure of core competencies, aligned with the complexity and interdisciplinarity required by the digital transformation of naval systems. Our team is composed by doctoral researchers, naval engineers, AI specialists, and applied scientists, coordinated under a modular research framework that ensures flexibility, depth, and scalability in every initiative. Our competencies are structured around three strategic pillars:

1. Pillar I – Foundational Scientific and Technical Excellence, includes deep theoretical and practical knowledge in:
 - Artificial Intelligence & Machine Learning, with emphasis on deep learning, reinforcement learning, and large language models (LLMs)
 - Data Science and Latent Space Modeling, including feature engineering, dimensionality reduction, and unsupervised learning
 - Multiphysics Simulation, combining CFD, FEM, and hydrodynamic modeling for vessel design and system behavior prediction
2. Pillar II – Integrated Maritime System Knowledge, domain-specific expertise embedded in the lifecycle of maritime and fluvial projects:
 - Ship Design and Interior-Exterior Configuration, including optimization of space based on energy and ergonomic analysis
 - Energy Efficiency Modeling and Control Systems, involving AI-driven inference of operational metrics and embedded system behavior
 - Human-Machine Interaction and Intelligent Interfaces, supporting remote assistance, digital twins, and predictive design feedback
3. Pillar III – Applied Computational Infrastructure and Collaboration, competencies to scale, deploy, and operate our research platforms:
 - High-Performance Computing and On-Premise AI Infrastructure, leveraging NVIDIA GPUs and distributed processing for training and simulation
 - Secure Multi-user Access and Research Collaboration Platforms, including Git-based versioning, VPN-secured clusters, and shared datasets
 - AI Research Translation and Industrial Scalability, transforming computational prototypes into industry-applicable tools and services

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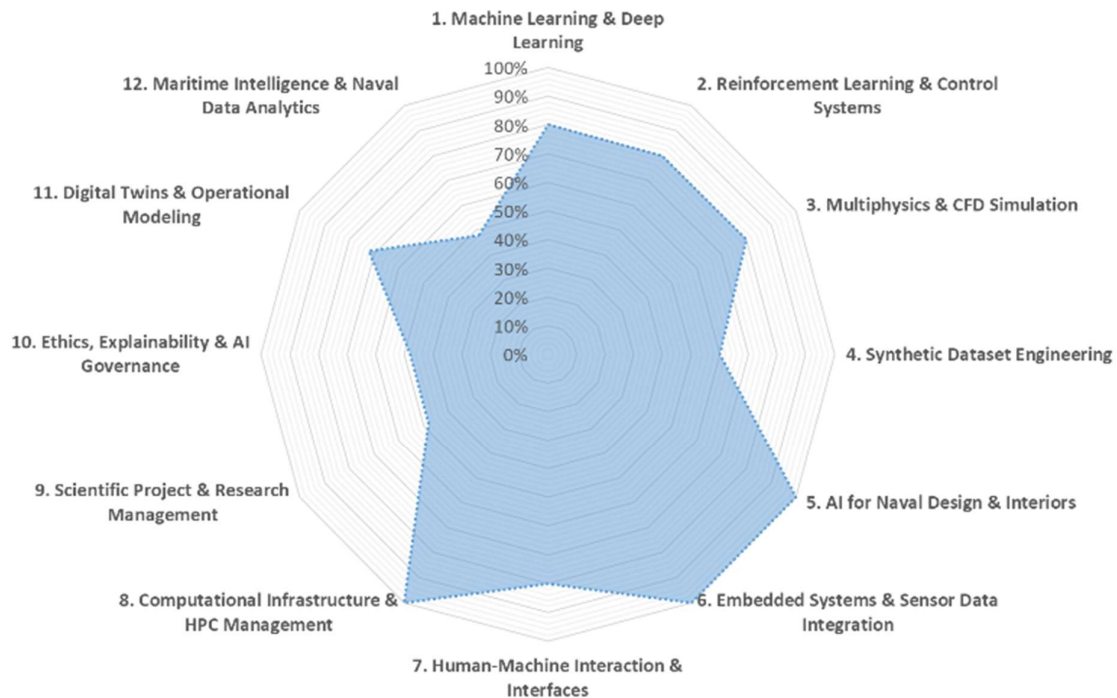
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To support this framework, CIII-MAF operates with an installed R&D capacity of 6400 research-hours monthly, housed in our secure data and computing facilities in Guayaquil. Our team is expanding progressively as we onboard new researchers and partner with academic and industrial stakeholders in Latin America and beyond.

All research lines are coordinated through modular, data-driven initiatives that evolve with the complexity of the challenges we face. Our Competency Radar is not static—it is an evolving matrix of skills designed to adapt, learn, and lead innovation in the face of a rapidly transforming maritime and computational landscape.

APPLIED RESEARCH & COMPUTATIONAL INNOVATION - RELEVANCE CORE COMPETENCIES



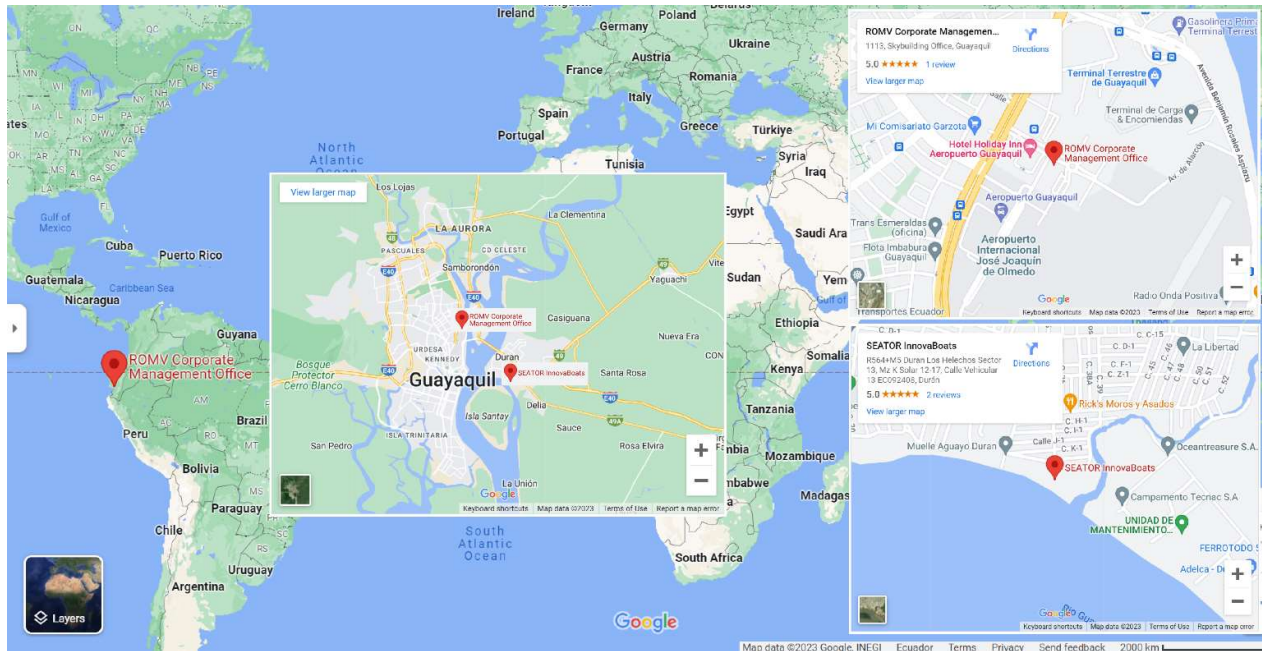
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