



Vol. 25 No. 1



Dr. Emery Coppola, shown here working on groundwater data being utilized by his Artificial Neural Network.

How Artificial Neural Networks Work

A form of artificial intelligence, ANNs “learn” directly from data by processing representative data patterns through their internal architecture. The internal architecture consists of nodes, analogous to brain neurons, interconnected by complex mathematical functions, analogous to brain synapses. During the learning phase, the ANNs minimize their learning error by adaptively adjusting the relative strengths and weaknesses between the interconnected nodes. This learning paradigm is similar to human learning, where certain pathways in the brain are adaptively strengthened during certain learning activities or experiences to reinforce cognitive abilities. That is, the neurons in the brain fire in response to different stimuli, which promotes learning.

Update to Clients

Update

SAI Engineer Uses Artificial Intelligence to Optimize Environmental Solutions

Artificial neural networks (ANNs) were first developed by researchers in the late 1940’s as an attempt to mimic and understand the human brain. They have evolved over the decades and are now recognized as one of the most powerful computational techniques available.

Dr. Emery Coppola, Senior Engineer at Sadat Associates, has applied ANNs to a variety of applications. He co-developed a methodology that uses ANNs for managing water resources in real-time, which received a United States Patent. He has applied ANN technology to problems that include forecasting water demand, algae blooms, groundwater levels, groundwater quality, energy consumption, and commodity prices, among others.

During his research, Dr. Coppola combined ANN with optimization to identify the optimal trade-off between drinking water supply volume via supply wells, and the vulnerability of those wells to contamination, for the Parkway Wellfield in Toms River, NJ. This wellfield attracted media coverage (Time Magazine, 1999) because of an alleged cancer cluster that was believed to be linked to the contamination. An epidemiological study found evidence of a weak link between the two. Dr. Coppola developed ANN groundwater flow simulation models that were used to generate a trade-off curve. Conflict resolution methodologies were then used to identify the ideal pumping rates in accordance with the preferences of the various stakeholders.

The power of ANNs is that they learn directly from easily measured real-world data and can achieve prediction and simulation accuracy that exceeds the most advanced physical-based model, which was

developed at far greater cost and effort (Coppola et al., Journal of Hydrologic Engineering, 2003).

SAI envisions many different applications in which the ANN technology can be used to promote more effective decision-making that will ultimately help protect resources and reduce operational costs in the environmental sector. As the economic crisis spreads and deepens, there will be a greater demand for cutting edge technologies to reduce costs and improve efficiencies. In addition, as environmental problems grow and resources diminish, decision-makers will require more accurate real-time prediction and optimization capability to manage scarce and often irreplaceable resources more effectively.

Examples of ANN applications that SAI’s Dr. Coppola can perform for environmental clients include:

- Drought prediction for water purveyors and government agencies;
- Energy demand forecasting for utilities;
- Analyzing the optimization potential of electrical transmission systems;
- Forecasting water quality trends related to both natural and man induced stresses;
- Flood forecasting for design and regulation; and
- Predicting crop failures

If you have a potential application to discuss with SAI, please contact Dr. Coppola by phone at 609-826-9600, or by email at ecoppola@sadat.com.

INSIDE

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SAI Client Proposes Dramatic Factory Site Transformation

Fieldstone Associates Inc. of Newark has been aggressively pursuing brownfields redevelopment throughout New Jersey over the last three years. SAI assisted Fieldstone in developing and implementing a cleanup of a factory site in North Bergen (see article on page 4) as well as Mays Landing, N.J.

Several years ago, Joseph Wiley, SAI's Senior Vice President, discussed the possibility of pursuing redevelopment of properties in Frenchtown, N.J. where Joe had lived previously and served as Planning Board Chairman. Mark Bellin, President of Fieldstone, negotiated a deal to purchase a 5.5-acre factory site at the edge of Frenchtown's residential area.

Frenchtown is a charming town on the Delaware River. It was built around local mills including a branch of Star Porcelain of Trenton. The Frenchtown Ceramics Plant dates to the early 1900's and covers over 100,000 sq. ft. After the ceramics plant closed in the 1980's, an ECRA cleanup was completed.

SAI was hired to conduct due diligence to determine the adequacy of the prior cleanup for the conversion of the property to residential use. SAI found that further cleanup would be needed to meet unrestricted residential standards. The cost of site acquisition and cleanup made the developer realize that project feasibility would depend on creating a relatively dense design including a total of 88 units.

A major hurdle in the project has been the need for rezoning from industrial to residential. After much deliberation over concept plans presented to the Planning Board, a recommendation for a zoning overlay to allow high density residential development at former industrial sites was presented to the Borough. Borough Council is in the process of adopting an ordinance based on the recommendations.

Fieldstone used a concept that integrated a sense of Frenchtown's history into the design (which extends the existing street and alley pattern), incorporates Victorian elements for single and two-family units, and includes several taller factory-style apartment buildings to mimic the town's industrial architecture. To incorporate further historical elements, Mark Bellin and his architectural team visited the parent company's defunct factory in Trenton. The new owners of the building offered examples of ceramic manufacturing machines for outdoor sculpture and original blueprints of the porcelain objects to decorate the lobbies of the new apartments.

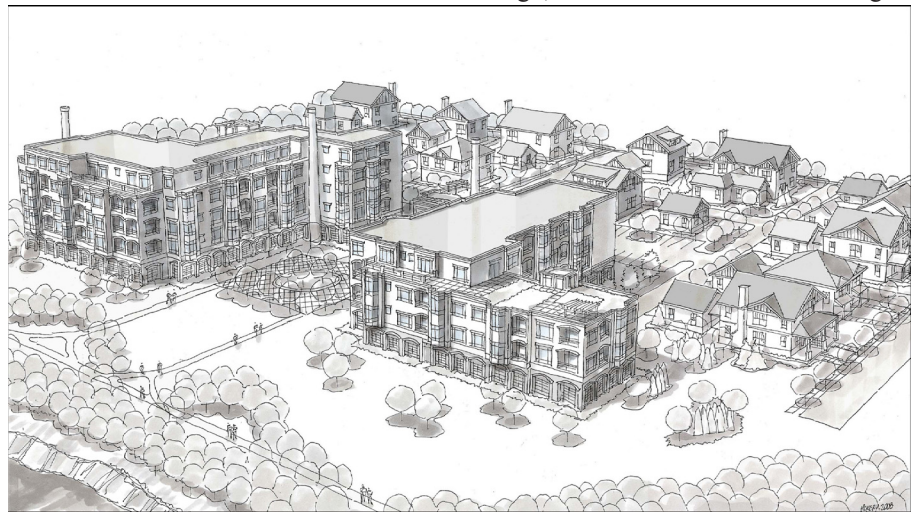
As Mark Bellin put it, "Creating a project with historic connections is not what conventional builders are likely to propose. We needed to satisfy the Borough that our project would fit well into the community. With an efficient use of land and attraction design, we can still build in a challenged market."

Status Report on Mercer County's New Criminal Courthouse

SAI has been assisting the Mercer County Improvement Authority (MCIA) with environmental consulting services relating to the demolition of an existing parking and detention center to make way for the construction of a new County Criminal Courthouse facility in Trenton, NJ.

SAI completed a geotechnical study of the subsurface soils including the installation of soil borings and test pits. Based on the data collected, SAI provided recommendations for 1) earthwork for site preparation; 2) excavation requirements; 3) determination of suitable floor slab support systems; and 4) design parameters relating to foundation systems and basement walls.

SAI also assisted MCIA with the completion of a groundwater investigation including the installation of monitoring wells and the implementation of aquifer pumping tests. Data from the pumping tests aided in the characterization of the groundwater table conditions and the recommendation for the need for a groundwater management/dewatering system during



Site Rendering of proposed development at Frenchtown Ceramics Plant, courtesy of Melillo + Bayer Associates, Landscape Architects.

SAI Helps Preserve and Beautify the Banks of the Raritan River

In November 2008, SAI's client, Edgeboro Disposal Inc. (EDI), completed the ongoing stabilization of



Summer 2008, at the newly restored and landscaped site.

the bank of the Raritan River along Area 3 of the Edgeboro Landfill and adjacent Lot 1. The stabilization project was designed by SAI. The Edgeboro Landfill is a 320-acre site located on Edgeboro Road in East Brunswick, New Jersey. The Raritan River, the longest river in New Jersey, flows from New Brunswick through the northern border of the site into the Raritan Bay. The bank of the river located just downstream of the NJ Turnpike Bridge on the landfill side has been subjected to erosion and degradation for many years.

EDI, the current owner of the site, undertook remedial efforts to preserve and improve the environmental quality of this area by stabilizing the riverbank. SAI assessed various stabilization options (such as self-adjusting armor, rigid armor, flexible mattresses, flow deflection approaches and vegetative approaches) with respect to site characteristics. After performing thorough geotechnical, hydraulic and stability analysis, riprap blankets, a type of self-adjusting armor, were chosen as the best stabilization strategy for the area.

Salient features of SAI's stabilization design included the excavation of some of the deposited

material in order to provide a 3:1 slope for riprap placement, as well as using toe keys for anchoring



The newly planted river bank. Photo taken in June 2008.

the large stone into the ground. SAI's design was approved by the NJDEP, and construction activities began in early 2007. Part of the site preparation work included the placement of geotextiles and sand to support the riprap. The installation of the riprap was completed in early 2008. Approximately 3000 feet of the riverbank were stabilized as a part of this project.

After the environmental remediation work was finished, the area was landscaped to restore its natural habitat. In coordination with EDI and the Edison Wetlands Association (EWA), a nonprofit group interested in the preservation of the Raritan River, only native tree, shrub and grass species were selected for the landscaping. SAI oversaw the planting of native maples and oaks, and native shrubs such as winterberry holly, sea myrtle, summer sweet and dogwood. NJDEP officials visiting the project site after completion applauded EDI's remedial efforts and SAI's design in restoring the riverbank ecotone and providing aesthetic beauty to the riverbank.

An article in the November 2, 2008 edition of the *Star Ledger* reported that Mr. Jack Whitman, President of Edgeboro Disposal Inc., affirmed his

company's commitment to environmental safeguards in a written statement. The newspaper also quoted Robert Spiegel, EWA's Executive Director, as saying, "Now the old landfill... is a lush green peninsula with huge boulders protecting the shoreline," and indicating that the restoration of the riverbank will revive ecotourism along the Raritan. In the near future, EWA plans to invite students from the Rutgers University to study the project as an example of remedial measures for ecosystem preservation. Thanks to EDI and SAI's design, the students can continue to derive inspiration from the University's alma mater, "On the Banks of the Old Raritan..."

Welcome!

Ms. Chokshi has joined SAI in our Engineering Department. She has a B.S. in Environmental Engineering from L.D. College of Engineering in India, and an M.S. from the University of Maryland.



Jiturvi Chokshi

After working four years in India on permitting, environmental audit reports and government compliance issues, Ms. Chokshi is helping SAI as a project engineer on several of our landfill projects, focusing primarily on compliance and permitting issues.

Mercer County Courthouse, continued from page 2

construction. SAI also assisted MCIA with the preparation for a City of Trenton sanitary sewer system discharge permit for groundwater to be pumped from the excavation to allow for the installation of footings and foundations.

Innovative Cleanup Washes Away Residual Contamination

As reported in our Spring 2008 newsletter, SAI's client, JFK Condo Developers LLC, took on the challenge of remediating an old industrial facility located in North Bergen, Hudson County. In addition to historic fill materials, the Remedial Investigation for this former garment manufacturing site, which took place under the leadership of Suzanne Macaoay, SAI's Vice President of Science, had documented evidence of discharges associated with underground storage tanks located under the building. The Remedial Investigation/Remedial Action Workplan submitted to NJDEP by SAI for the site received approval in May 2007. The remediation of the site was scheduled to coincide with the demolition of the former factory building.

As part of the demolition, SAI sampled the 200,000-square-foot concrete and brick structure so that clean masonry suitable for use as structural fill could be segregated for reuse on-site in accordance with NJDEP's Guidance Document. The result of this effort was NJDEP's approval for the reuse of almost all of the concrete aggregate generated by the building's demolition.

As demolition progressed to the bottom floors of the building, the locations of specific areas of concern, such as sumps and floor drains, were documented. Subsequent to the final removal of the building's basement floor, SAI used a GPS unit to verify the location of these areas and evaluate each for evidence

of a discharge.

The removal of this floor also revealed the concrete of the building's footings and walls were extremely thick and had been constructed to bear directly on bedrock. Fortunately, these features had served to contain the heating oil that had discharged from piping runs located under the building and prevented migration of this material beyond the building's footprint. Consequently, the majority of this material was removed from the excavation via vacuum truck.

The unique challenge to completing the project was the bedrock's glacially polished and convoluted surface, which impeded the use of conventional equipment to remove the contaminated soil and residual product. To solve the problem, the bedrock surface was sprayed with a biodegradable citrus-based degreaser, then rinsed with a fire hose. Afterwards, the oily water generated by this effort was removed from the excavation by the vacuum truck. The outcome was highly successful: all residual product was removed from the rock face.

As a result of this innovative action by SAI and the contractor, remediation of the heating oil was completed. No long term remedial efforts will be needed. The client is now ready to begin construction of a for-rent residential project of 128 units.



Before commencing the degreasing,...



... and after completion. What a difference!

From the Editor -

If you would like to receive a full-color electronic version of our newsletter in Adobe PDF format via email, or if you want additional information about SAI and its services, please email me at: lthompson@satad.com.

Thanks — we look forward to hearing from you.