

# RETRO-CLAD

## Design and Development of Alternative Retrofitting Strategies for Existing Building Envelopes, utilizing Recycled-paper Prefabricated Cladding and Shading Systems

[Adonis Cleanthous, Markella Menikou, Nina Eliassides]

**Abstract**—The research tackles the urgent issue of upgrading existing buildings' envelopes in order to comply with current codes and regulations (European and local) concerning energy performance. The proposition involves the design and development of alternative retro fitting strategies for existing building envelopes utilizing recycled paper prefabricated cladding and shading systems. The project is titled "RETRO-CLAD" and stands for Retrofitting Cladding.

Currently the already built environment outweighs the new-built. Most existing buildings do not conform to expected energy standards. The "RETRO-CLAD" research aims to provide vital information to relevant local authorities and organizations in order to consider strategic planning of action, updating building codes and general shifting the emphasis on the already built rather than the new-build. There is currently virtually no policy in place for upgrading existing buildings for energy performance.

The "RETRO-CLAD" utilizes low tech production methods through the use of mostly recycled materials in surplus abundance in the local market. The properties of its main recycled ingredients are known to already be in-line with the basic desired characteristics of high performance modules. The "RETRO-CLAD" will bring together a multitude of performances into a series of modules and eventually into a system utilizing sustainable approaches. Aimed for performances include improved thermal, vapor, shading and acoustic properties, increased thermal mass, reduced maintenance and considerable extension of the building's life-cycle.

"RETRO-CLAD" will offer strategies for planning and implementing building envelope upgrades with a series of possible designs and products that are 'smart', high performance, low emission, versatile and with multiple application possibilities. As such, it is hoped and estimated that the "RETRO-CLAD" will have a positive impact on the existing built environment and therefore secure a sustainable future for our cities.

**Keywords**—retrofitting, building, cladding, shading, architecture, building components, prefabricated, components, recycled, paper

### I. Retro-clad Research Objectives

The research tackles the urgent issue of upgrading existing buildings' envelopes in order to comply with current codes and regulations (European and local) concerning energy performance. The proposition involves the design and development of alternative Retro Fitting Strategies for existing building envelopes utilizing recycled paper Prefabricated Cladding and Shading Systems. The project is titled "RETRO-CLAD" and stands for Retrofitting Cladding.

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provide vital information to relevant local authorities and organizations in order to consider strategic planning of action, updating building codes and shifting the emphasis on the already built rather than the new-build. There is currently virtually no policy in place for upgrading existing buildings' envelopes for energy performance. The existing local incentives for double-glazing upgrades and roof thermal insulation are deemed insufficient as they only address a small fraction of the problem.

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The aim of the research is to explore the possibilities of utilizing sustainable approaches. These will include the minimization of embodied energy and carbon footprint of the new proposed cladding, as well as promoting social sustainability approaches including the re-introduction of human labour in the relatively 'low-tech' production and application method.

The "RETRO-CLAD" project will bring together a multitude of performances into a single product.

The "RETRO-CLAD" utilizes recycled paper surplus as its main ingredient of up to 90% for the proposed cladding and shading systems. This responds effectively in the effort to initiate and increase the local utilization of recycled paper. At the moment paper comprises 26% of all recycled materials locally that unfortunately gets shipped abroad for processing due to the lack of local industry able to absorb it.

The "RETRO-CLAD" solves two major problems of Building Envelopes Energy Upgrades with a single product. It will eliminate the current high embodied energy in building products, and the need to combine different products to achieve required building performances. The "RETRO-CLAD" will put forth alternative strategies and design

development (cladding and shading) for Retrofitting Components providing:

- Increased and multiple performances in a singular modular building component such as very high thermal insulation, low weight, good compressive/tensile strength.

- Minimal environmental impact as it utilizes local recycled material, therefore minimizing the embodied energy and carbon footprint of the product. It also offers possibilities for environmental disposal upon completion of the lifecycle of a building (through composting).

The above added values of “RETRO-CLAD”, reflect positively on scientific, environmental, technological, financial and social concerns.

- The research will help shift the Energy Policy Emphasis from the New-Built to the Existing buildings. This is vital both quantitatively as well as qualitatively: The already Existing and non-energy compliant, is in excess of 98%, whereas the yearly new-built and energy compliant, is less than 2% of the total Built Environment.

- Currently the global energy consumption of buildings alone is approximately 30% of total global energy expenditure. Coupling this fact with the ubiquitous nature of the built environment, the broader societal impact (common good) has a trickledown effect from the broader built environment, down to the individual user or inhabitant increasing quality of life on a multitude of levels.

- The “RETRO-CLAD” will provide new data, strategies, design and development useful for Energy, Planning conducted by professional bodies and state authorities.

- The “RETRO-CLAD” will rejuvenate a local industry currently in decline and create the base for future offspring of “RETRO-CLAD” relevant industries.

- At the moment, the local construction industry uses imported cladding and shading components most of which all use primarily new (virgin) materials, such as aluminium, fibre-cement, and reconstituted stone (concrete). These common cladding products when utilized for retrofitting, must necessarily be used in conjunction with additional thermal insulating materials. The “RETRO-CLAD” components, will address these adverse attributes, by utilizing almost 100% recycled material and offering Energy Upgrading consolidation into a singular product.

- Currently most imported building products are deemed climatically inappropriate, as they respond to northern European climates and are therefore not suitable or performance oriented for Mediterranean climatic demands.

The “RETRO-CLAD” will be strategized and developed considering both production and implementation. It will consider less expected innovative methods. The current industrial production trend tends to usually consider products worth producing, only if it is possible to serially produce them in massive quantities, expediently, and with minimal human labour. These are commonly perceived as requirements for the ‘success’ of the product. In the case of the “RETRO-CLAD” these fast-track/massive output requirements are questioned. The project proposes an alternative production method involving so called ‘low-tech’ processes and crafting, relatively lower production output, but not necessarily more costly.

The “RETRO-CLAD” is conceived as a close relative to the vernacular mud-brick (adobe), but here technologically improved and ‘industrialized’ to respond to contemporary building performance requirements and specifications, as well as to growing environmental concerns arising from current construction industry practices..

### **A. Specific Scientific and Technological Objectives of the Research**

The project aims to develop a new and innovative method and practice for retrofitting existing buildings towards energy upgrading, as a viable alternative to current industry practices.

- On the scientific level the “RETRO-CLAD” consortium brings together the Academic based research (H.O.), the manufacturing industry (PA1), and the architectural/ engineering design and implementation industry (PA2) in seamless cooperation, assuring a broader definition of hierarchies of scientific objectives. The commonly divergent priorities and objectives of academia, manufacturing and design will be assessed and cross-fertilized in a fruitful manner to best serve the development of a new methodology addressing issues across the board, ranging from inception to implementation.

- The resultant Retrofitting Cladding and Shading Systems will fuse and resolve concerns that are commonly limited and singularly focused such as the academic research environment’s focus on innovation, the manufacturing industry’s focus on financial viability and profit margins and the design industry’s focus on performance and implementation. The otherwise restricted scientific objectives will be re-informed and enriched through a broader prioritization.

- The overarching objective is to develop strategies that rely solely on locally sourced materials (recycled paper), respond sustainably to both optimum production processes and building construction industry demands, as well as respond to the specific required local climatic (Mediterranean) performances.

- The aimed product characteristics will be designed and tested with quantifiable and scientifically measurable qualities in a cyclical or more accurately a ‘spiralling’ process. This means that a desirable design will be developed, physically implemented, tested and then utilising the data provided through this research cycle, it will be re-designed, re-implemented and re-tested; completing a number of cycles towards optimum product characteristics. These spiralling cycles will occur both on an individual ‘module’ level as well as a comprehensive ‘system’ level - meaning an adequate number of modules together as an integral building construction system.

These characteristics and properties will include among others:

- Very high thermal insulation properties
- Utilization of recycled material (paper /grey water) decreasing its carbon footprint
- Minimal embedded energy in its production (no firing process, minimal energy embedded in its components)
- Compatibility with existing building structures in the local and Mediterranean region
- Very light weight (by volume)

- Excellent buildability (larger units / less erection time and labour)
- Good thermal mass provision from its interior facing mass
- Water resistance to be increased with polymer coatings
- Excellent sound insulation properties
- Very high tensile strength (high seismic performance)
- Adequate compressive strength (with possibility to increase with other additives)
- Adequate fire resistance with possibilities of increased resistance
- Good possibilities for integrative installation of building services (plumbing, drainage, electrical, general ducting)

The abovementioned intended product specifications, will be holistically assessed and prioritized according to viable alternative output scenarios. For example aiming to 'increase compressive strength' might be deemed unnecessary beyond a complying to code level as it will compromise more highly desirable 'thermal insulation' properties. It is therefore vital for the project proposition to avoid singular focus or over-appreciation of a limited number of individual properties data. The overall scientific and technological objectives of the project will allow for broad, synergetic, and comprehensive assessments of resultant individual data, culminating in a creative and guidelines directive towards an innovative and 'smart' product.

## II. Existing Knowledge in Retrofitting and Retro-clad project innovation

### A. *Retrofitting: Building on Existing Knowledge*

Throughout the long history of architecture and the evolution of the built environment, a close relationship of material availability, climatic response and socially/culturally relevant design may be observed. This is evident through an array of different time periods, different cultures, and different geographical locations and climatic zones. This apparent historic holistic approach to the built environment is generally believed to be associated with a more direct and 'practical' utilisation of available material and technology towards the provision of 'shelter'. In addition it evidences a historically stronger bond between vernacular architecture (folk, architecture without architects) and high architecture (monumental and/or designed-for).

This close relationship with the natural environment and its processes seems to have collapsed with the 18th century industrial revolution, as both the new production of building materials as well as building erection processes afforded an increased liberation from the restrictions of the past (such as material availability and hand-crafting technologies). A further disassociation of the built environment from the natural environment occurred with the advancement during the late 19th and early 20th centuries of mechanical systems for

building conditioning (heating/cooling/ventilation). These mechanical provisions allowed buildings to be designed and erected without any climatic or energy considerations, as thermal comfort would now be solely provided by mechanical and electrical installations. Contrary to this trend, more recent environmental and sustainability concerns have started to reverse this dissociative trend. The current world view of the built environment is one with minimum environmental impact, or even positive environmental impact.

The vision of the proposed "RETRO-CLAD" project is to deliver a building construction product and system that will have a positive impact on the existing built and natural environment while advancing new and alternative technological and scientific knowledge, leading to improved built environments for Human Habitation.

The proposed Cladding and Shading for Retrofitting Buildings is completely new and innovative as there is currently no existing precedent or product that utilises either the same materials, manufacturability processes, or comprehensive combination and coordination of qualities.

The basic proposed ingredient of recycled paper turned into a building construction material, has been in the last decades explored as small scale, custom-crafted, in unique building applications; usually as a pourable mixture cast in-situ (in on-location custom erected formwork), as a building wall system. These precedent trials of recycled paper into building materials have been carried out rather informally, usually based on small-scale trial-and-error experiments, commonly without the scientific support or data that might lead to improvements and process directives. The casting in-situ approach practised so far, also poses logistical problems such as on-site pulping of the paper, on-location paper pulp pumping, the erection of on-site wooden formworks and the necessarily slow process of pouring a thin layer of the pulp at lengthy time intervals in order to allow for natural drying.

The common practice of utilising recycled/pulped paper in the construction of buildings as outlined above is therefore labour intensive, slow and ineffective; lacking necessary control of parameters such as exact measurements, accuracy of ingredients and processes, variables in temperature and humidity, and inevitable environmental conditions unpredictability issues.

The "RETRO-CLAD" project therefore proposes research into the possibilities of designing, specifying, and determining manufacturing possibilities for serial prefabrication of cladding and shading systems under controlled factory environments. The proposed research results will open up a new array of possibilities. The new prefab prototypes will be scientifically tested for compliance with European and local building codes regarding energy efficiency and rated characteristics of other performances such as tensile/compressive strength, sound insulation, water and fire resistance, embodied energy, carbon footprint, thermal mass provision, and vapour resistance.

Currently the commonly used cladding components for retrofitting in the building construction industry are aluminium, clay or concrete based. All have a long and tested

history: clay components being one of the oldest building technologies perfected and ubiquitously promoted by the Romans, and aluminium and concrete components being a more recent invention with the advent of rolling and extruding processes as well as of Portland cement in the late 19th century. All of these types of materials require an extraordinary amount of energy for their production, which translates to adverse qualities in embodied energy and carbon footprint. Clay components require a firing process, aluminium components require high energy in its forging and rolling and concrete requires very high heating of limestone for the production of Portland cement. They also all require extensive mining in sourcing their raw ingredients (clay, bauxite, sand, silica, gravel). When employed to clad the existing building envelope of buildings, all of these types of commonly used materials require additional layers of a host of other construction materials such as thermal insulation materials, as they cannot comply with minimum energy code requirements as a stand-alone material. This necessity, adversely complicates construction systems with negative scoring on erection speed, labour and added long-term building maintenance costs. The “RETRO-CLAD” research, proposes a singular component comprehensively responding to all retrofitting requirements.

Taking its clues from traditional vernacular masonry components such as mud-bricks (adobe), the “RETRO-CLAD” project will propose cladding and shading components that alone and without the layering of major other additional construction materials, may score highly in most required performances, and towards a more sustainable and environmentally friendly Built Environment.

Going back to the basics, and reconsidering the binary “low-tech”/“high-tech” may afford a series of previously unthinkable and untapped “smart” products and systems.

## ***B. Retro-clad Project: Innovation and Originality***

The “RETRO-CLAD” project proposes innovation and originality on two main axes:

1. Recycling matter in a completely new use (such as paper into building construction cladding systems)
2. New and alternative concepts in manufacturing processes (such as ‘slow’ versus ‘fast’)

In more detail:

1. It is a known fact that the common practice of recycling any specific material for the production of the same as the original product, reduces the quality of the resultant matter and the overall specifications with every additional cycle of reprocessing (such as paper to paper, glass to glass, packaging to packaging, etc.).

It is also a known fact that the European and local market is already becoming saturated by the abundance and surplus of recycled materials and the lesser demand for the same regenerated products. The recycled paper produced in many European countries for example, is hardly ever absorbed by

local paper and carton industries, forcing some countries (such as Sweden), to utilise recycled paper as bio-mass. More or less all European countries ship recycled paper overseas for processing. Both practices (bio-mass conversion and shipping) are less than environmentally desirable as they defeat sustainability concerns by increasing the carbon footprint of the operation.

Both above observations (reduction of properties in same-to-same material recycling manufacturing, and surplus recycled paper availability) point to the urgency for alternative and ‘unlike’ approaches.

The “RETRO-CLAD” project proposes a radically new solution: surplus recycled paper into a building construction product.

2. The “RETRO-CLAD” project will promote the acquisition of new knowledge and skills, bringing the partners to the forefront of developing innovative, smart and environmentally friendly products for the building construction industry.

The local construction products manufacturing industry has been and still is reliant on archaic and conventional practices. It produces older and basic prototyped products such as extruded and fired clay bricks or concrete blocks with minimal or no compliance to current energy performance standards, or environmental conservation concerns.

The local industry’s reluctance to investigate alternative practices is exacerbated further by the lack of in-house ‘research and development’ departments (RTDI). There is therefore currently an overall negative climate that assumes effort towards innovation as ‘risky’ at best and often ‘unnecessary’ as well.

The current stagnancy in the relevant industries may therefore be rejuvenated by the “RETRO-CLAD” project. “RETRO-CLAD” will expand the local industries’ range of products.

The assumption is that the only viable and profitable way for industrialising products is by maximising quantity and speed of output and minimising human labour involved. These assumptions will be questioned by the “RETRO-CLAD” project by offering viable alternatives such as ‘slow’ and ‘crafted’ processes.

The new manufacturing possibilities will be made viable by offsetting assumed added costs by diminished costs in other areas, such as in the acquisition of ‘raw’ materials and inventive non-linear manufacturing processes. Instead of investing exuberantly on new high-tech manufacturing machinery and equipment, “RETRO-CLAD” proposes minimal machinery investments and much larger human-labour investment. The added values of positive environmental impact and expanded labour and employment should also be calculated in the cost/gain parameters as in the near future the manufacturing industries will be called to pay for their operations and products contributing to social sustainability through the employment of human labour.

By introducing and resolving alternative processes, The “RETRO-CLAD” project will also open up further future possibilities in both the same field of industry, as well as in altogether different ones. Further future applications might include prefabricated systems for emergency housing, basic modular building components as well as built-in interior components and furniture. The “RETRO-CLAD” resolutions for small-scale and ‘niche’ manufacturing industries are expected to substantially improve the emergence of new operations locally and possibly Mediterranean-wide and Europe-wide. It is expected that it will stimulate economic growth and contribute directly to social progress and sustainability.

### **III. Analysis and Description of Research Methodology Towards Implementation**

The overarching methodology for the implementation of the proposed project is a “spiralling” one. This method involves a non-linear approach. All major objectives and results stemming from separate groups of activities will be re-targeted and re-assessed within each additional cycle of the project development process, until reaching the intended maturity of the useful and ready-to-apply deliverables. This “spiralling” methodology is chosen to best reflect and deal with the nature of the proposition. The diverse interests of the consortium partners (academic research, manufacturing industry and architectural design industry) will induce a desirable process of enriched and dynamically informed questions and accordingly prompt multi-responsive resolutions. No pre-assumptions are allowed to predetermine a singular direction. Rather, with every question posed, a multitude of possible solutions will be investigated, and synergetically assessed together with yet other bifurcating possible solutions generated by a host of other questions. In every consequent cycle, the most viable and promising solutions will be re-tested within a yet regenerated ever advancing and refined questioning environment.

#### **A. Parameters and specifications:**

In this activities bundle, the following are proposed:

a. Gathering data on existing research. The academic partner H.O. will collect and evaluate relevant existing research, and where appropriate translate and transfer the knowledge towards problem-definition and focus areas. Gaps of knowledge will be defined as primary research targets with cataloguing of tasks. Similarly, the industry partners will collect and evaluate relevant design industry knowledge, manufacturing processes and accordingly propose selected “technology transfer”.

b. Both the academic and industry partners will conduct selected case study assessments. These may include theoretical propositions as well as physically practiced and tested ones.

c. Studying, comparing and contrasting relevant products existing in the current construction industry market, as well as selected products from other fields that exhibit

similar concepts. Cataloguing, assessing the data and outlining directives for the project.

d. Developing and defining the aimed-for specifications, and reassessing these at every stage or cycle of testing, either through simulation (drawing and calculations), or through physical making and laboratory measurements.

e. Setting the parameters of the actual material components, the type and proportion of ingredients (constituent parts), as directed by converging results between theoretical applications, design and configuration alternatives, and physical mixing and testing.

The geometry and sizing (design configuration) will also be set as preliminary parameters at this stage. These will evolve with every consequent cycle narrowing the design parameters to the optimum achievable.

#### **B. Design and development from basic module towards a system.**

In this activities bundle, the following are proposed:

a. Determining the appropriate sizing and configuration of the module. All partners will provide drawings and calculations taking into account different design criteria and intended performances. The architectural design partners will develop drawings responding to questions of varied existing building scenarios such as different types of principal structural systems, different types of infill walls, and responses to elevational variation such as openings for doors and windows, corner, bottom and top conditions, and existing architectural details. Like-wise the academic partner will provide drawings and calculations in response to similar questions but framed through theoretical testing of possibilities. Questions of handleability, tolerances, and logistical sequences will be more in depth inquired for. The manufacturing industry partner will provide drawings and calculations of module alternatives considering efficient and productive manufacturability, (type of mould and geometry, time needed for bonding, drying and turn-around of daily production cycle, effective packaging and transportation). A variety of appropriate connectors will also be designed and developed.

b. Reciprocal re-informing of designs, oscillating between the singular module design and the grouping of a minimum amount of modules behaving as a system. As with design concerns of part ‘a’ above, data resulting from design assessments on the module will redefine design parameters for the system, and back again to the module until aimed design performances are met at both scales. This will involve cladding and shading systems separately, as well as in compatible systems.

c. Production of catalogues of possible solutions exhibiting the most promising qualities. This will be the result of activities a, and b, as above, and will consist of drawings, analyses, and qualitative assessments in an easily retrievable information catalogue. All partners will contribute, with the academic one weighing in more substantially with relevant expertise on this task.

### **C. Physical sampling, physical testing, and resulting data evaluation.**

In this activities bundle, the following are proposed:

a. Designing and constructing a series of alternative formworks. The partners will collectively select the 10 most prominent and promising different design configurations for a module. These will be selected on grounds of significant differences, and behaving alternatively to demands stemming from level of energy efficiency upgrade demands, manufacturability possibilities, as well as response to construction site conditions and existing building specification variants. Consequently 10 different moulds and corresponding moulding methods will be designed, constructed and prescribed.

b. Developing through actual and physical trials the ideal mixture of ingredients, identifying the basic constituents, the differences in shifting proportions, and secondary array of additives required (or not). A number of varied samples will be produced with varied methods, curing and drying processes.

c. Designing an accounting for efficient and effective manufacturability process. This will include among other, the method of soaking the recycled paper, the mixing and pulping process, the casting method of pouring mixture serially/seamlessly into moulds, the washing/reusing of moulds, the off-casting of units, the design of drying racks and its environmental control systems, the short-term storage and the logistical processes.

d. Laboratory tests and qualitative assessments of varied in design and ingredients potential physical prototypes. These tests and evaluation will include the majority of critical to the design values such as compression/ tensile strength, thermal insulating values, fire, water and mould resistance, thermal mass provision, weight, and moisture content.

e. Comparative assessment, qualitative and quantitative, of the properties of the actual and physical modules produced and tested as in 'd' above. The partners will produce catalogues that easily access the information in a composite design/drawing/method documentation/individual characteristics and overall evaluation.

### **D. Systems integration and design leading towards fine-tuning project results**

In this activities bundle, the following are proposed:

a. Testing on a larger scale the 'as built' characteristics and performance/behaviour of the prevailing cladding and shading module, into an actual constructed wall system. This will be of an approximately 3m (L) x 2m (W) x 3.20 (H) construction of an assumed exterior corner of an existing building envelope. It will test real life and true environment conditions. The process of actual construction will test issues of 'ease' of handling, connectors types, tolerances, geometry and sizing consistency, tools, machinery and human labour know-how requirements.

b. Testing live compatibility with varied existing buildings' conditions such as finishes, varied primary

structural systems in both vertical and horizontal arrangements (columns and beams).

c. To design, install and evaluate other systems to be integrated. These may include mechanical electrical, plumbing and structural.

They may also include live testing of integration of common building elements such as doors and windows with relevant connectivities, seals, flashings and lintels.

The live conditions of installation processes and consequent reactions and behaviour of the 'RETRO-CLAD' system in complex and demanding integrative conditions, and within 'live' environment (sun, rain, humidity, wind, temperature, swings) will provide the essential information for finalising design and concluding with the fine-tuning of all product parameters.

## **IV. Retro-clad Project Benefits and Impact**

The project proposes a completely new strategy, implementation method and ultimately possible products and production method.

The cladding and shading system components is to be utilised as a singular and comprehensive solution for the 'envelope' (exterior, perimeter walls) of buildings. The product is not limited to specific types of building in terms of use (residential, office, retail, public), nor to its technical/physical make-up (structural system, building services concepts), and not exclusive to a single type of climate (hot and arid, temperate, cold and dry etc). As such its future application potential is estimated to be vast in both range as well as overall quantity: almost the entirety of the existing built environment could potentially utilise the new product ("RETRO-CLAD") and benefit from its added values such as maximum thermal insulation for both hot and cold climates, high energy efficiency, ease and speed of erection, acoustic insulation, low embodied energy, utilisation of recycled resources, building life-cycle re-cycling, and others as outlined in previous chapters.

It is therefore vital that the "RETRO-CLAD" project will have a 'trickle-down' effect with impact on a wide range of beneficiaries. The positive impact will benefit the very broad natural environment trickling down to the industry, and finally to the individual user (inhabitants of the built environment).

The built environment currently consumes 30% of the total energy spent on the planet. The average human being, currently spends 80% of their life inside buildings. These two facts alone point to the wide impact the "RETRO-CLAD" project may have. The future of the natural environment and the wellbeing of the individual person is heavily reliant on the quality of the built environment. As such, the "RETRO-CLAD" project will fulfil an urgently needed strategy in remedying and redefining the essence of the 'built' part of the equation.

The "RETRO-CLAD" project not only proposes a new strategy and product, but also a completely new way of perceiving 'industrial manufacturing' and production methods. The reason that large manufacturing companies have not considered the utilization of recycled paper as a raw material

for the production of building components is the misconception that all manufacturing must obey uniform rules to safeguard its success.

The current stagnancy in the relevant industries may therefore be rejuvenated by the “RETRO-CLAD” project.

The above proposed alternative to common industrial manufacturing processes is estimated to energise and generate a large number of new small and medium manufacturing companies (SME). The “RETRO-CLAD” project will offer a ‘niche’ of alternative, small scale ‘slow’ and ‘crafted’ production methodology naturally protected by the competition from large industries.

The “RETRO-CLAD” project is expected to yield a number of innovative results, leading to potential licensing of intellectual properties and product and methodology copyrights. As the local manufacturing industry currently relies heavily on purchasing and acquiring licensing of products developed by other (international) companies the potential in-house licensing is estimated to be of very high value. Likewise for the design and academic partners, it will be a unique asset, as the current local licensing and patenting output is at a critically low level.



Markella Menikou is an Associate Professor and is the Associate Head of the Architecture Department at the University of Nicosia.

She received a B.A. (Hons) in Architecture with First Class in 2000, and a Bachelor of Architecture with Distinction in 2003 from the Manchester School of Architecture. In 2007 she completed an M.A. in Bioclimatic Architecture from the same university.

She is also a Specialised Expert for Certificates of Energy Output for Buildings, Ministry of Commerce Industry and Tourism, Energy Service. She received scholarships and funding from the Cypriot Government and in the UK for high academic achievement.



Adonis Cleanthous is a practicing architect and Associate Professor of architecture in the Department of Architecture, University of Nicosia. He is a holder of an M.Sc. in Advanced Architectural Design from Columbia University, Graduate School of Architecture Planning and Preservation. He is also a holder of a B.Arch from the University of Oregon, USA.

He has been practising architecture since 1993 through work in numerous local practices, as well as through his own practice “Cleanthous + Eliassides”, established in 2002. Cleanthous has been awarded a number of prizes in architectural competitions including the first prize and building commission for the university of Cyprus “social facilities” building complex for the new campus, an extensive facility of varied educational and social programmes.

He represented Cyprus in the Venice Architecture Biennale in 2008 with the project ‘Easylove’.

Recent interests through practice and academic development include construction and building technologies, and more specifically the design and manufacturability of pre-fabricated building components.



Nina Eliassides is a professional architect consultant. She received her Bachelor of Architecture in Design from University of Illinois at Chicago in 1996. She had worked at a few practices in Nicosia for six years. In 2002 she was awarded first prize in the architecture competition for the ‘Student Union Building Complex’ a 12.000m<sup>2</sup> project at the University of Cyprus campus, and a subsequent commissioning. She had designed and implemented the project as primary partner in the practice of Cleanthous + Eliassides Architects from 2002 to 2010. The Practice had completed a number of projects ranging in program and scale. Her practice has also been awarded prizes in additional architecture competitions such as second prize for “the English School Teaching Facilities” in Nicosia, and an honorary award for the “National Theater” building, also in Nicosia. Her completed project for the University of Cyprus has been nominated for a Mies Van Der Rohe Award.