Temporal processes in research, green building and material reuse

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ABSTRACT:

Design to reuse materials has been difficult to systematize in the built environment. Incorporating reclaimed materials pushes the boundaries of the processes of standard materials selection, sourcing, and use. This paper will examine the melding together of a process of building deconstruction and an intensive group design process, to create a way for materials reuse to become more universal while not losing the trans-mutational qualities of reclaimed materials as they evolve from one building to the next. These tandem processes allow designers and builders to develop an attitude toward salvaged material that leads to an integrative method to guide the design, and conversely, the design to guide the reclamation process. The practice of design / build is a strategy to link sustainable design methodologies to the harvest of discarded materials and buildings. Design and building are often a process of reconciliation between process, material and vision. Quantifiable processes are a mode of operation that can be overtly included in the visioning for such projects.

In the deconstruction of a 150-year old barn addition and the building of a mobile shade structure at Yestermorrow Design / Build School in Warren, VT in the summer of 2010; the students and instructors engaged in a tandem process of deconstruction and design / build. The project led to a method in which assessable results and methods were considered in depth and were laid out within a larger structure for conveying the temporal possibilities for salvaging and designing with reused materials. It was the confluence of that practice and the group design / build procedure in a compressed amount of time that led to a materials transformation and use schema that hints at more universal possibilities in the future.

CONFERENCE THEME: Ecology, sustainability, and changing societal and political economies.
KEYWORDS: deconstruction, design / build, reuse, sustainable design, life-cycle

INTRODUCTION

There is a gap in sustainable building design research and practice with regard to one of the most effective means of reducing environmental impacts while engendering cultural and aesthetic possibilities. This gap exists between the first end-of-life (EOL) of buildings and the potential for their reformation; it is a potential to generate a systematic and yet creative practice embodied in the extended use of materials that might otherwise become waste. Built works can be seen as temporal products of an on-going process of building, as opposed to fixed artefacts. This stance incorporates the perspective of design in service to time-based processes of collaborative design, construction, use / users, change, and end-of-life to reconstruction. The transition of materials from deconstruction to reconstruction can become a phase where investigations take place to more fully realize ecological life-cycles of building.

Deconstruction can be defined as the selective dismantling of building structures to recover the maximum amount of primarily reusable and secondarily recyclable materials in a safe and cost-effective manner (Guy 2006). Tandem deconstruction / design / build and materials-use processes can provide exemplars for sustainable design methodologies. Stewart Brand writes of architecture being "trapped" by insisting that it is "the art of building", when it could be redefined as the "design-science of the life of buildings." (Brand 1995).

The reuse of materials has been hard to quantify and replicate in a universal manner in construction. Incorporating reclaimed materials into designs pushes the boundaries of the basic processes of materials selections, sourcing, and use. A rare example of taking on this challenge is the Materials Testing Laboratory by Busby + Associates Architects. This project utilized reclaimed materials from structural to finish systems and was eventually commissioned as a project management team with the responsibility for the reclaimed materials more or less placed entirely on the design team (Taggart 2007). Breaking with traditional roles for the architect was key to this project's success.

This paper will examine the melding together of a quantified process of materials salvage and deconstruction, and an intensive group design process that created a way for the output of materials reuse to become more universal while not losing the trans-mutational qualities of reclaimed materials as they evolved from one building to the next. A parallel process allows designers and builders to develop an attitude toward salvaged materials that integrates the materials into design, while the design is also guiding the reclamation process. Design / build is a practice of reconciliation between process, material and vision. Measurable outcomes and formalized processes might be more overtly included in these types of projects to enable research and education for practitioners and students, respectively.

Even with the codification of architecture and construction in the modern era around concerns for life, health and safety, and more recently environmental criteria, materials conservation is not typically a priority in the design process (Osmani 2001). The research and teaching described herein is predicated on the idea that the processes of recovering materials from existing buildings, and designing to retain their useful functions and embedded energy is a relevant form of practice. This practice, although specialized, offers the construction industry an opportunity to be its own material stock in lieu of the ever expanding extraction of resources from the natural environment and return of waste. It also encourages local materials use and the values espoused by 'slow design' by making these principles real, and learning them by practicing them. According to Slow Lab:

> "'Slow Design' is a holistic approach to creative thinking, process and outcomes. It envisions positive human and environmental impacts of designed products, environments and systems, while constructively critiquing the processes and technologies of which they are born. It celebrates local, close-mesh networks of people and industry, it preserves and draws upon our cultural diversity, and it relies on the open sharing of ideas and information to arrive at innovative solutions to contemporary challenges. Slowness doesn't refer to how long it takes to make or do something" (Slow Lab 2010).

This deconstruction / reconstruction practice is not predicated on purely environmental metrics such as CO2 emissions avoided, or reduced volumes of materials deposited in landfills. It is also a practice of connection to the memories of the past, to materials qualities, and embedded materials culture of regional building and craft traditions (Adams 1998). Conducting building dismantling with the goal to reuse the materials in a design / build project and then actively integrating the deconstruction and reuse process with the design process illustrates design stewardship for architects and students that expands the notion of buildings from the present tense of 'built' to a time-based reality of 'building'.

1.DECONSTRUTION

1.1 OPERATIONAL PRECISION FOR UNIVERSAL HARVESTING

Relative to the processes of deconstruction, the methods detailed here arise directly from repeated experience in taking apart and salvaging buildings. Students in the "Design for Deconstruction and Reconstruction" course at the Yestermorrow Design / Build School, Summer, 2010, engaged in deconstruction, assessment and processing of salvaged lumber as a method for sourcing materials. At the same time, they integrated the materials into a design methodology that folded into an integrated group-design process.

The procedure for deconstructing a building is fraught with risk and discovery. Every old building has its specific challenges, and its peculiarities. Similar materials may have many variations based on construction and use impacts. The process of extracting materials from a building with a history, and construction that predates current methods requires a measured and exacting approach. The consideration of the progression of dismantling must first start with a contemplation of the end point. What are the material goals for this building in a second life? This process of reflection at the beginning of the design includes an assessment and categorization of the materials to be reused from an old building into a new project along the following three categories:

- Repeat – reuse same: materials that are easily reusable as-is and can be reused the same way while retaining the maximum amount of original integrity and appearance of use with little to no alteration.

- Renew – new and different use: see materials that can be used differently with creative processing, and may include a change in their qualities to be more like new, i.e. "cleaned-up".
- Rethink – new + old: see materials that can be made like-and that can be combined with new materials to in effect make a different product that is then used in a different way than the original, however still as reuse.

Each categorization provides a waypoint to familiarize the possibilities of materials reuse. The categorization must be fairly systematic, can be ongoing and includes discoveries that happen as the process unfolds on-site. The possibility of change and discovery is controlled through this rigorous categorization. The chart below shows how materials were assessed in a previous project using these categories of materials possibilities. It gives both guidance and a set of possible benchmarks against which a harvest can be compared at the end of the process (Guy and Williams 2003).

Material	Potential Uses	Repeat	Rethink	Renew
Bead board	Interior wall and ceiling finish or wainscot	•		
	Cabinetry or door panels			•
Brick	Walkway, fireplace, planters, decorative column base, landscape screen wall	•		
1x4 T&G flooring	Flooring	•		
	Flooring mixed with new wood flooring of same profile			•
1x6 Novelty Siding	Used as an interior finish on the common wall between the main building and The Project		•	
	Used as part of a door panel		•	
1x8 Roof Sheathing	Shelving		•	
	Casework		•	
2x4 Framing	Interior partition wall framing [1]	•		
2x6 Floor Joists	Exterior wall framing [1]		•	
4x6 Floor Beams	Wall framing [1]		•	
	Remilled rustic window sill or exposed door header			•
Solid wood cabinets	Casework	•		
Freestanding pass through cabinet	Casework	•		

Fig. 1: Identification of potential design palette in an existing building's salvaged materials

Establishing safety and work processes on site sets the stage for the orderly consideration of such a possibly disorderly object. The formalization of a set of fundamental concepts is intended to begin the process of inculcation into the 'unbuilding' and 'harvesting' thought processes. There are many simple aphorisms used to convey mindfulness as students begin to see the rational process in simple steps:

"Clean up as you go"
"Treat the materials to be salvaged as though they were yours"
"Be aware of others and your center of gravity"
"Remove the connection not the material"
"Know the structure"
"Work from the point closest to the exit into the building"
"Consider multiple routes to remove materials as directly to the ground as possible"
"Use the building as a scaffold"
"Always know which "pile" a material goes to before removing it from the building"
"Carry "naily" boards the least distance and the un-nailed boards the most distance over their journey"
"Use the appropriate tool for the task and minimize effort through the physics of leverage"
"Move the trailer or truck to the materials not the other way around"
"Analyze a removal process: by each sub-activity in sequence; tools; potential hazards and steps to mitigate them"

The goal of these expressions is to convey a state of attentiveness to context, detail and most importantly time and flow of an unbuilding process. It might be said that deconstruction knowledge is a form of heuristics, referring to "experience-based techniques for problem solving, learning, and

discovery" (Heuristics 2010). The deconstruction process is often times a discovery through problem-solving, in a partially known and partially unveiling context. In these terms it is perhaps a mirror image of the design / build process.

1.2 CHOREOGRAPHY AS MATERIALS TRANSFORMATION

Heidegger's notion of the linguistic correlation between art and craft lies in the Greek's use of the word techne for both disciplines. Techne is finally defined by Heidegger to mean a kind of practical performance. (Leach 1997). This idea of performing a task as a way of furthering one's technical understanding is a mode of thinking about the deconstruction process. It is a kind of dance to take a building down to its foundation, as the group did in Vermont. The choreography of that dance serves to create a rhythm and space for consideration of materials that lead the group to innovate with the lumber taken from the site. This innovation is in direct relationship to the tandem process and techne that has arisen from the repetitive choreography of deconstruction. Here, the categorization of materials and staging is critical.

The rigorous management through consideration of a sequence and rhythm of matter extraction allowed for material innovation. An initial assessment of existing structure is just the beginning. Structure, non-structure, openings, pathways, vertical and horizontal relationships of the building describe the deconstruction choreography. This choreography results in a careful consideration of how the materials are sequenced in their removal. Throughout the entire process, the building must remain stable, and allow for itself to act as a self-scaffold for working. At the same time, avoiding the creation of any barriers that impede efficient removal of materiel is a priority. The structure must on occasion be systematically and artificially stabilized as an extra-precaution; but the goal is to avoid this as much as possible.

Part of this consideration of order and efficiency is to assess which parts of the building are core structure and original construction, which is secondary structure, and which parts are added at later time periods. In the case of the 1850's Vermont barn, it was clear that the entire structure to be removed was built later than the core to remain. But within that younger portion, there were materials and parts that were added even later, had not fared well and were non-structural. Non-structural, non-core walls closest to circulation are removed first so that their component parts can be assessed and broken down, and gotten out of the way. These were quickly removed and assessed for reuse. As one set of materials or building assemblies was removed this created a new set of physical dimensions, pathways, openings, and so on, from which to base the optimal flow of the next set of materials. "LOFO: Last on First Off" is a way of thinking about this staging. At the same time an attempt is made to focus on materials types and as much as possible create similar groups of recovered materials at each step. As we mention here, this planning must be considered in detail prior to the commencement of deconstruction.

The scene of the site also becomes part of the dance of techne. The removal of materials from the building is the first complicated step of this dance of reuse. The image below shows a triangular organization developed by one of the instructors through much repeated experience with deconstruction. This triangle staging area allows for each piece to be removed directly, undergo a superficial processing as it is removed and re-assessed, and subsequently stored for processing. Removal may occur based on timing or organization of the transport, reuse by others, etc.

The repetition of this judgment by various parts of the team, while also considering design possibilities within the project led each member to have thoughts about material application that came from an immersion in the harvested material. This repeated divining of suitability gave each team member the opportunity to develop tectonic sensibilities about the design / build project that were both overt and subtle; again, here material choreography leads to material knowledge. It is through this repetitive choreography and assessment of materials - repeat, renew, rethink - that the team was able to unlock a more universal and agreed upon attitude towards the salvaged lumber.

1.3 DESIGN / BUILD

This project proposes an architecture design sensibility that is akin to a performative art. This tradition is realized in the modern version of the design / build concept (Mannell 2006). A focus of design / build education and tradition is the Yestermorrow Design / Build School. The Yestermorrow Design / Build School was founded in Warren, VT in 1980 by John Connell (Palladino-Piedmont 1997; Sagan 2008) Principles of design / build practice include: control of the economic production of buildings by the designers themselves, speculative development as practice as opposed to traditional architectural practice models, a desire for hands-on direct physical involvement by engaging in the materiality and empirical qualities of architecture, and creative and artist expression in the medium of architecture and building (Sagan 2008). A non-technical definition of design / build is as follows: "about the art of making buildings, rather than making information for others to make buildings" (Piedmont-Palladino 1997). This lends itself to the idea of building making as a performative act. It is, in effect, a process of designing through building and within context as literally as possible. While some amount of planning is essential a key distinction is that the work is begun before a complete conceptualization is accomplished, and therefore the time and experiences of the building process become integral to the shaping of the final product.

Photo 1: "Work triangle" for materials coming building under deconstruction

The ultimate result of this design/ build method as practiced via Yestermorrow School is of dynamic buildings that evolve from an active process rather than any predetermined idea (Sagan 2008). Schon espouses a theory of knowledge based upon reflection "in action" and reflection "on action" that is often described as reflective practice. This reflective practice allows for both givens and opportunities for change within a design process (Swann 2002). Design, as distinguished from art, is a social process for the designer in relation to a team, a client, and the project context. As such this approach to building lends itself to a complementary relationship with the rigorous and detailed dissection of existing buildings for the sometimes uncertain harvest of materials. The open-ended nature of realizing built form in direct physical conception, is a way that material discovery can lend itself to material innovation. This innovation is then allowed to be tested on the harvest, and drive the design as the concurrent process of design and material gathering move forward together.

2. PROJECT DESCRIPTION

In the deconstruction of a 150-year old barn addition and the building of a mobile shade structure at Yestermorrow Design / Build School in Warren, VT in the summer of 2010; the students and instructors engaged in a tandem process of deconstruction and design / build. The project was designed so that results and methods were considered in depth and are laid out within temporal possibilities for salvaging and designing with reused materials. It was the confluence of a measured deconstruction practice and a group design / build procedure in a compressed amount of time that led to a materials transformation and use schema that hints at more universal possibilities in the future.

Photo 2: View of barn from the Southeast with secondary structure to be removed on the right

Photo 3: View of barn from the Northeast with secondary structure to be removed on the left

Photo 4: Back wall being removed by group effort

Photo 5: Main element after removal of secondary element

Photo 6: Salvaged lumber at Yestermorrow

Photo 7: Materials dressed from the site and experimentation in the shop

2.1 DECONSTRUCTION

The students and instructors in one week systematically took apart and salvaged a large portion of a 2-story 2,400 square foot heavy timber building. The building was originally built in three stages: the core barn which was a simple gable-roof structure; then a shed-roofed extension spanning the long side of the south side; and another smaller addition off of the first addition. This final addition was severely damaged and was removed before the project started. The deconstruction in this project consisted of removing the first addition, a 2-story element approximately 16' x 24' seen in Photo 2 & 3 extending from the main structure. Although the roof was tied into the roof of the main element

at a mid-point on the primary structure rafters, it had a separate post and beam frame which allowed it to be removed independently of the main element in a line with the main timber frame. The main timber frame throughout was in-filled on the exterior walls with vertical 2x4 framing onto which the exterior siding was attached. The roof was metal v-crimp roofing attached to 1 x sheathing. The preliminary steps in the process were to categorize the main materials and their relation to the potential design and functional qualities of the proposed shade structure.

Without resolving either the actual yield of the deconstruction or the final design of the new structure, a dialogue was established in the conceptual and schematic design stages, which continued as the deconstruction began. The initial planning of the deconstruction revolved around safety, logistics of the movement of people, tools and materials, and the basic sequencing of the process in terms of the last-on, first-off construct (with variations created by the requirement to leave the main building element in a stable and protected condition). With multiple possible uses for the materials in mind, the materials harvest is segregated into categories of disposal, recycling, and reuse: with the reuse further segregated for potential reuse in the follow-on reconstruction of the main barn on-site; reuse by the project team; reuse by others such the Yestermorrow School in the future.

For each category their disposition is planned: placed inside of the main structure for reuse by the follow-on project; a 'metals pile' for recycling; waste bagged or piled where it can be easily picked-up; and project or Yestermorrow reuse processed such as de-nailing, rough trimming, stacking in categories for loading on a pick-up truck or trailer. This further categorization of the materials, beyond the broad reuse or recycle categories described above, is by type, dimensions or qualities within a single type. The possibilities for the treatments of repeat, renew, and rethink described earlier were then able to be considered.

2.2 GROUP DESIGN / BUILD PROCESS

Based on a group process first developed by Jersey Devils founders and design build pioneers Steve Badanes, John Ringel, and Jim Adamson; the material harvest group engaged in an intensive on site design process that centred on preparing to re-use the harvested materials. This method worked to bring students together around an idea, and to allow students to explore new ways of making that they have not had an opportunity to be involved in. (Badanes, 2009) The universal professional studio practice is as follows: schematic design, design-development, and construction documentation and construction administration. (Demkin, 2008) Design / build practice is a truncated version of this in which the construction documentation and construction administration phases occur simultaneously with the construction phase of the project and design often bleeds into construction. (Beard et. al, 2001) In the design / build studio students are engaged in a process of learning by making something physical. This route can create a stronger link with materials exploration in the design process and in the final result. This reality differs from the usual studio process in that the implementation of the project causes students to fully question their assumptions about the design and the materials. (Wilkinson, 2007) It is this questioning that held value for this project. The fact that phases of a project which usually function discretely are now blended together leads to tremendous opportunity on this front. In the studio practice taught here, the group was asked to consider materials as a driving consideration for the design. Discussions about the possible use of what was being harvested were constant and on-going. The group was intentionally trying to discover ways of making through the process of unmaking. In setting forth on the design portion of the class, the process was laid out as follows.

2.3 BUILDING CONSENSUS

The group process to build consensus behind one larger idea occurred in tandem with materials discussions and explorations as the harvesting moved forward. The group deconstructed during the day, and designed at night for 3 days. The daytime discussions on site centred on how what was being taken from the site could be efficiently used and processed, both in the project at hand but also in the larger community. The group started by coming up with individual ideas that were meant to satisfy the program of a sunshade for an existing plaza. Ideas of mobility and modularity were discussed at length and many options for program expansion and contraction were considered.

Students each came up with two or three ideas and the group categorized these ideas by their similar natures. These design categorizations lead to the forming of 4 smaller groups which then distilled and developed these into slightly more coherent group ideas. The groups got larger through several rounds of design over several days that were filled with deconstruction work on site following the rigorous deconstruction methods laid out previously.

After considering many options and the similarities between them, the group finally found consensus in the possibilities of making the sunshade mobile for use on any part of the existing campus. This led to the discovery that the shade part needed to be extremely light. During the day, participants were taking heavy hundred-year-old boards out of the building on site. The contrast between the heaviness of these boards and their possible use was considered as work progressed both on-site and in the design studio apace. As the groups' ideas coalesced, a large volume of design sketches were generated that became more and more specific. These sketches lead to a series of smaller working drawings which were produced as the building of the agreed upon design commenced. As building grew the participants were encouraged to consider their design idea while harvesting the materials on site and material attitudes began to come into focus.

Photo 8: Group design and sketching

2.4 MATERIAL PROCESS: LEARNING BY MAKING

Material thought and research was then conducted in smaller groups which became the driving forces in different parts of the project and worked to solve issues within each of these parts. This progression started with materials investigation which included processing the material on the site, categorizing material based on the three ideas of repeat, renew and rethink; bringing back portions to experiment with and sketching possible uses for different types of material. In this way the schematic phase of design became an active participatory phase with materials as part of this phase. The continued daily engagement on site also contributed to the shift in how this phase functioned. The fact that here, the group design process also overlapped with what would be the design development phases in a more conventional design progression; and both were occurring by the same set of hands, led to a feedback loop of materials reuse and dressage.

2.5 LOOPING ON-SITE MATERIAL HARVEST AND HARVEST CENTRED DESIGN

At a certain point in the one-week process the group became a machine for looping the ideas from the site into their project. After the initial design sketches were completed and consensus reached; the group started to focus on how they were assessing and dressing the materials on site and at the fabrication space. Broken into groups that included wing, structure, wheels and connection; each team produced detailed material experiments. This team approach to both taking apart and building was the key to making discoveries and creating a group lexicon for using the materials. This led to an almost frantic processing of site materiel as construction went on.

One example of this is the direct and rigorous process by which many 150 year old boards were processed on site, and in the wood shop. They then became integral to the project. The project design that emerged from the group process required lightness by its very nature. Because the group had settled on a mobile project, the fact that many of the salvaged boards were quite dense and heavy with beautiful graining became one point of experimentation in the group. The teams undertook a process of denailing and planing that revealed true value in the salvaged material and was extremely repetitive in nature. This process revealed that by long cutting or ripping the boards into flexible strips, one could create lighter yet stronger truss structures that allowed for the light-frame construction required by the mobile sunshade program. By making strategic planning and cutting decisions the group was able to leave some of the original rough-hewn salvaged surface intact and create beautiful newly sawn surfaces that were appropriate for precise building. In this way a feedback loop was developed between material experimentation, the rigors of site material selection, dressing of lumber, and the design / build process. It is our belief that this loop which took place on several levels in this process, including working with salvaged hardware and heavy timbers for the structure of the project, hints at a more universal possibility in salvaging buildings. If design and salvage can be undertaken rigorously and at the same time, the peculiarities of the building carcass and specificity of the desired finished object begin to meld to each other in a way that allows greater efficacies for both processes. In other words deconstruction and reconstruction become one process.

Based upon a survey-based estimate by one of the authors, reused building materials sold annually in the US (excluding antiques, specialty products, etc.) is approximately 0.2% of total debris generated from building activities (construction, renovation, demolition) in the US each year. The overall reusable fraction of building materials debris is anywhere from 5% -25% of total debris generation dependent on project type and materials of construction. A new construction project may have materials in excellent condition, however generally this waste is in lesser states for reuse. A renovation or demolition project has potentially the entire stock of the building however the effects of construction and use may lower its reusability. Nonetheless, there is potentially a 25-125 times increase in the amount of 'wasted' materials yet to be reused annually before reaching the full potential for reuse of building materials per year in the US.

In this project, the deconstruction resulted in approximately 30% of the existing materials recovered for reuse by the project, by Yestermorrow, or by the community (clean wood and metal roofing); 30% recovered for recycling (clean wood); and the remainder as disposal (primarily painted wood). The class used as much as was needed to complete the design / build project and the rest was left for future reuse by the Yestermorrow campus. This project exceeded the statistical norms for material salvage and the authors believe this to be due to the difference in practice here. The pairing of design and build processes with deconstruction meant that the users of the materials were actively participating in their salvage and processing. This we believe has led to higher efficiency in volume of salvage, and also community interest in the salvaged materials for other uses.

Photo 9: Assembly-by-design process

Photo 10: Assembling the components

Photo 11: Final result

CONCLUSION

Richard Sennet in his book "The Craftsman" explores a concept he refers to as "being as a thing" he maintains that at a certain point in the process of making after a definite amount of time; one reaches mastery of a process and a maker no longer feels a separation between their hand and the act of making (Sennet 2008). This idea of mastery is attainable within the realm of deconstruction and it democratizes the reuse of materials. It is achieved at the point when the materials are transformed through a rigorous on-site and in-shop process that feeds upon itself. In the project described here the process was both specific and universal. Through organizing the site, the choreography of the team and the repetitive nature of the tasks; the project began to emerge from both the process of deconstruction and reconstruction.

In this confluence of destruction and rebuilding, a fluidity of procedure emerged. Because the specificity of materials to be reclaimed, often limits applicability in the realm of construction; materials reuse has not been adopted as a widespread practice in the building industry. Evident in the interlocking practice of deconstruction and design / build this possible universality may not be limited to student projects. At the same time both processes follow a defined logic that creates a methodology that is specific and flexible, in other words when practiced concurrently, these procedures allow the materials to be used more fully. Clearly, a robust and rigorous on-site choreography and assessment of materials, coupled with an equally rigorous design build process, leads to an extremely efficient use of reclaimed materials. The project described here left behind a store of useable material both on site and at the fabrication site that was utilized by other groups and the surrounding community. By partnering the deconstruction with immediate group centred re-construction-universal dissemination of reclaimed materials became possible around the project. The hope is that through a continued approach to projects such as these, the ability to reclaim buildings and materials within the existing built landscape will not be held back by the specificity of the beginning and end points in the process.

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