From Pits and Piles to Lakes and Landscapes: Rebuilding Minnesota's Industrial Landscape Using a Transdisciplinary Approach

M. Christine Carlson, John Koepke, Mirja P. Hanson

Landscape Journal: design, planning, and management of the land,
Volume 30, Number 1, 2011, pp. 35-52 (Article)

Published by University of Wisconsin Press

From Pits and Piles to Lakes and Landscapes

Rebuilding Minnesota's Industrial Landscape Using a Transdisciplinary Approach

M. Christine Carlson, John Koepke, and Mirja P. Hanson

ABSTRACT The Laurentian Vision Partnership is a collaborative planning and design initiative that explores local and regional redevelopment opportunities for depleted iron ore mine lands on Minnesota's Mesabi iron range. The initiative involves an ad hoc coalition of local, regional, and state representatives from industry, business, communities, education, and government dedicated to advancing the long-term vitality of the region. The initiative is also a land-based case study in the development of transdisciplinary action research. The initiative has employed participatory design tools to promote and maintain collaboration, discourse, and knowledge building across diverse knowledge bases, within a land design framework that considers how changes in active mining processes can regenerate the region's future ecological and economic environment. This paper outlines the initiative and its projects and methods. It reflects on the partnership's results and challenges through a review of project documentation, capacity building case studies, and the authors' professional practice in regional landscape planning, site design, and participatory decision making, as managing members of the partnership since 1999.

KEYWORDS interdisciplinary collaboration; non-traditional partnerships; participatory decision-making; transdisciplinary practice; multi-objective mine land planning; land forming; mineland reclamation

INTRODUCTION

In 1997, representatives of United States Steel (USS) Northern Minnesota Iron Ore Operations met with faculty members of the University of Minnesota's Department of Landscape Architecture[1] to explore three questions:

1. Could the existing physical legacy of iron ore mining on the Mesabi Range (the Range) be changed?
2. Could mine engineers do a better job of rebuilding the landscape?
3. If so, how and for what purpose?

Minnesota enjoys a strong tradition in environmental conservation, restoration, and land management, but dynamic business conditions and political climates have challenged the creation of a positive landscape legacy for future generations in mine country. Both questions intrigued faculty members, especially because of the hydrological pattern evolving across the postmine landscape of the Range. Many former mine pits were filling with clean groundwater.[2] A new era of lakes and landscapes was emerging in the region, and opportunities for reconnecting natural systems, strengthening community relationships, and meeting the university's larger educational goals were portentous though unspecified.

Three years, countless meetings, arduous field trips, and intense workshops later, a small coalition of government, industry, community, and university professionals established four basic principles reflecting their intent in pursuing a new vision for the region:

1. Create design ideas linking planning decisions to actions that:
   - add value to the mine-altered landscape
   - open the door to economic opportunities
   - restore environmental vitality
   - protect jobs and the way of life on the range
2. Coordinate decision-making and build true collaboration among key interests.
3. Apply sound resource information to local and regional issues.
4. Get key parties to work on this direction now, including those making mine site designs for revised mining operations.

These principles not only embody the confidence that continuing industrial operations can make new places but also recognize the type and scale of collaboration among diverse interests and disciplines and across jurisdictional boundaries required to provide answers to the questions originally posed—questions that persist to this day.

This paper describes the work of the Laurentian Vision Partnership (the partnership) as well as the initiative that has grown from those early principles. The partnership comprises diverse individuals, groups, and institutions including state, regional, and local governments, current and former mining companies and related interests, mineral fee owners, funding organizations, community groups, educational institutions, and local, county, and regional businesses.[3] Each partner is

Landscape Journal 30:1–11 ISSN 0277-2426

engaged in the initiative at a different scale and with varying capacity and commitment. All are interested in improving working relationships between industry and community and in developing scenarios that will help the region retain its role as a productive and healthy landscape that provides a high quality of life in northern Minnesota.

The partnership's working hypothesis is that mining companies can shape certain active mines in strategic locations across the Mesabi Range to improve the region's cultural, economic, and environmental life (Bauer 1982, 2000; Schellie and Bauer 1968; Zube 1966). The partnership intends to use this hypothesis as the foundation of methods and processes to envision, plan, and develop alternative futures as the region moves from an extractive to a more diverse economy.

This paper also discusses the partnership's embodiment of transdisciplinary action research (TDAR), a process of integrated cross-disciplinary, interprofessional, and intersectoral collaboration proposed by Daniel Stokols (2006). According to Stokols, TDAR "requires a commitment to mutual learning . . . in which contrasting values and conflicts of interest are negotiated and accepted, if not entirely resolved" and often leads "to fundamentally new conceptualizations of scientific and societal phenomena" that "transcend traditional disciplinary boundaries that frame multi- and interdisciplinary analyses" (2006, 68). The authors propose that the partnership approaches TDAR on four levels:

1. The construction of new knowledge required to craft project outcomes and new products generated by partners.
2. The processes that have afforded a willingness of partners to understand each other's goals and issues, opportunities and constraints, and methods of practice so as to generate better outcomes.
3. The development of the ability to apply specific types of collaboration so as to develop and sustain deeper interest and longer interaction among partners and to formulate more sophisticated design and planning concepts related to the depth of issues and the time frame necessary to bringing about the vision.
4. The recognition and management of the Laurentian Vision's long timeline in the context of more immediate needs and aspirations of multiple partner agendas.

PROJECT OVERVIEW

Project Goals and Processes

Building trust among the various partners at the inception of the project in 1999, especially in trying to address the regional questions posed by a single industry representative, required intensive work, including extensive discussion and negotiation among all parties about the goals of the project. The original goals of the partnership were to:

- Preserve future mining opportunities and identify areas of high mining potential.
- Enhance the region's economic development and natural environment through resource management.
- Create a framework for comprehensive decision making about resource use.
- Produce planning and design tools for landscape reuse.
- Engage all affected parties in discussion and in design work that reinforces cooperation and builds effective working relationships across the range.

While easily stated, these explicit goals were difficult to achieve. The goal setting process elucidated diverse, often opposing, points of view in perceiving and describing the Range, and it exposed differences of opinion as to who should be involved in defining the future of the Range. These diverse points of view are not surprising in a region where extraction-based economies (timber, iron ore, taconite) have molded and, more than once, transformed culture, politics, and the landscape in little more than 100 years. Neither are such differences surprising, given state and county land management responsibilities and the complex

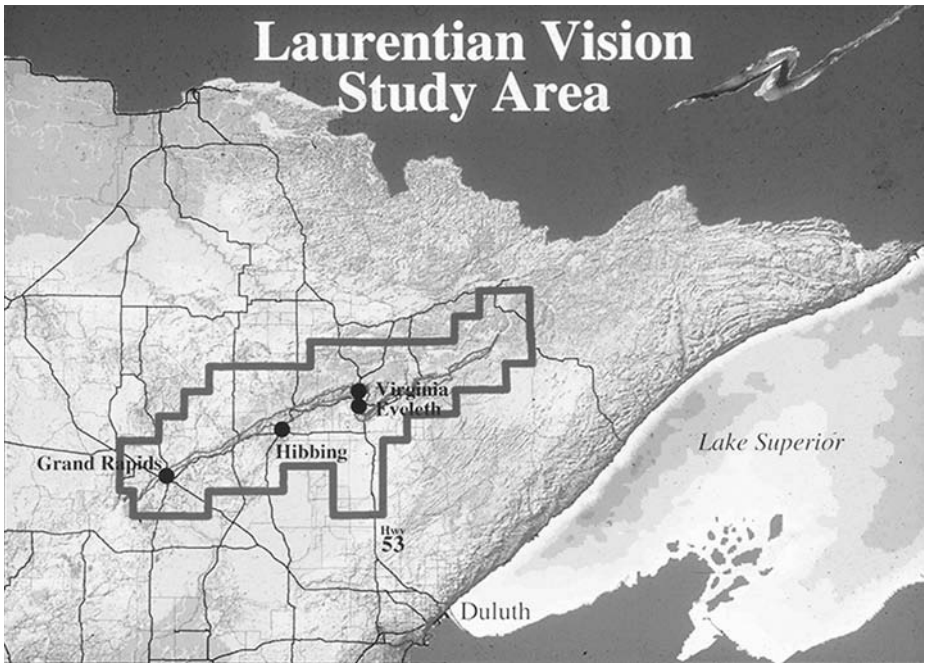


Figure 1. Map of the Mesabi Range.

private and public ownership and leasing relationships involved with mine lands.[4]

In addition, the partnership had no formal authority or ready resources to pursue and implement these goals. It built influence over time through the persistence and professional credibility of its partners and through innovative ways to access resources in a potluck style. The partnership uses unconventional but legal ways to receive, distribute, and spend funding. For example, over the years it crafted a variety of Memoranda of Understanding (MOU), sometimes fondly known as MO-IOU (Memoranda of I Owe Yous)! Thus the partnership was and still is an ad hoc organization, consciously structured to catalyze and facilitate the backstage activities involved in generating big ideas for the region, especially as they might relate to mine lands. In addition, most of the partnership's work precedes land planning in its focus on developing concepts and action strategies and on changing perceptions about mine lands as potential infrastructure for creating new economic and environmental futures in the region. This visioning strategy and the power of a persistent and systematic participatory approach with partners propelled the project for more than a decade, even through the ebbs and flows of political and financial support.

Landscape Context

Northern Minnesota is a rich, scenic, and rugged land of water, rock, and trees—tremendous territory for exploitation, as the timber and mining histories of the region attest. It is a dramatic and visual example of how landscape is the product of natural and cultural systems (University of Minnesota 1995).

The Mesabi Range extends 110 miles from Grand Rapids northeast to Ely and includes a distinctive bend that extends south from Virginia to Eveleth and back to the northeast (Figure 1). A continental ridge called the Laurentian Divide rises approximately 1,540 feet to 1,880 feet above mean sea level from west to east, forming the spine of the Range. It demarcates the intersection of three major watersheds—the Mississippi, Rainy River/Lake Superior, and Hudson Bay. Hence, water flows north and south out of the Range, feeding every major drainage basin in the Upper Midwest. Geologic processes operating billions of years ago produced the Biwabik Iron Formation just south of the divide (Pitt, Roos, and Fernandez 2003). The formation contains rich concentrations of soft hematite and limonite iron ores that are easy to extract because the formation is particularly close to the surface.

The mining landscape cuts a dramatic diagonal band across the region's natural and man-made systems. Open-pit mines form long, deep canyons or deep, clear lakes amidst hills of waste rock and historic iron ore piles. While forest is still the dominant regional land cover, especially in the undeveloped eastern parts of the range, the ecological landscape essentially is cut in two by mining and its concomitant urbanization.

Figure 2. The Mesabi iron range is a mine-altered landscape of deep-pit lakes and geometrically shaped surface stockpiles set against an endless forested horizon (Courtesy of University of Minnesota).

Wildlife habitats and water systems are fragmented or completely disconnected from one side of the divide to the other.

The visual landscape cuts an equally dramatic picture (Figure 2). Looking north from the Laurentian Divide, one sees mine stockpiles and processing plants punctuating an endless, flat terrain of forest and bog land. Active and former mines, roads, towns, and strip development hug the southern edge of the Laurentian Divide. Within this corridor, mine views are almost theatrical. Driving from west to east, one sees deep canyons and lakes and steep, often barren hills, defining the viewshed and creating a sublime, industrial scene made all the more vivid by the orange-reds that tint canyon and surface topography. Historical iron ore piles and modern rock stockpiles mark pit edges. Their conical and ziggurat shapes, designed to provide stability and minimize surface footprints, give the impression of a more ancient landscape dotted with ritual sites and primitive earthworks.[5]

Mining Industry Context

The Mesabi Range is one of 15 iron ranges located in the Upper Midwest and southern Ontario; it exceeds other districts in the extent of its mineral resources, especially iron ore (Pitt, Roos, and Fernandez 2003). Between 1900 and 1980 the range produced more than 70 percent of all total ores extracted and about 60 percent of the nation's output (Pitt, Roos, Fernandez 2003, 6). Today, six companies mine taconite, a lesser quality ore, and produce more than 40 million tons annually, about 3 percent of the world's total output.[6]

In just more than a century, national and global demands for iron ore, evolving and new technologies, and the impacts caused by competing foreign sources have induced cycles of boom or bust on the range. Today those cycles continue even as new steel technologies develop in the region and the prospect of mining nonferrous minerals becomes reality.[7]

Winchell and Winchell (1891) documented the discovery of iron ore deposits on the Mesabi Range in 1878. Iron ore mining by people of European extraction began shortly after 1890 and soon became the region's economic base. The once pristine woods of northeastern Minnesota, originally transformed by timber harvesting, underwent another conversion as deep ravines, open pits, spoil piles, and a few underground mines spawned towns, locations, and rails on the cutover.

Iron ore mining first began in deep, narrow underground mines. Miners shoveled the rich hematite (67 percent ore concentration) easily by hand, and conveyors hauled it from the underground vein to rail sidings where trains completed the ore's transport to Lake Superior ore docks. The shallow nature of the hematite ore induced mining companies to shift from underground shafts to open pits. Miners used steam and, later, electric shovels to scoop rock and rubble into railroad cars, which hauled the ore from pit bottom to surface for processing (Alanen 1989). In exposing the ore, surface mining activities heaped huge piles of trees,

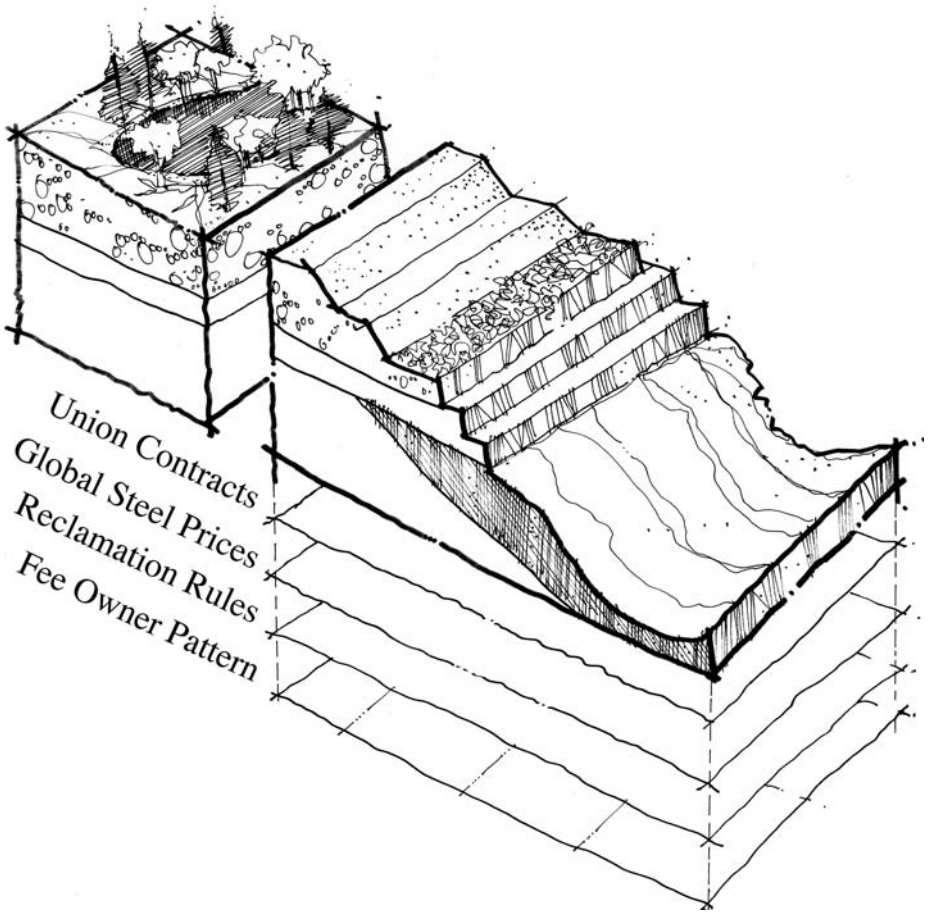


Figure 3. The Range landscape is a multidimensional product of geology, fee-ownership patterns, global steel pricing, state reclamation requirements, labor-union contracts, and surface water, soil, and vegetation. Understanding and using these inherently complex relationships provides collaborators with new knowledge, which enhances their capacity to achieve transdisciplinary approaches to landscape change (Courtesy of John Koepke/M.C. Carlson).

topsoil, and other surface materials (called overburden) on the edge of the mine.

By the 1930s, Mesabi hematite had become the major source of the world's iron ore, and it remained so until the 1950s, when its reserves were essentially exhausted. Mining companies then began extracting taconite, a lower quality ore, in even larger pits, using a new iron isolation and concentration process designed at the University of Minnesota (Davis 1964).

Taconite mining involves a systematic on-site process that isolates mined ore from rock, concentrates it, binds it with clay, and rolls and dries it into marble-size pellets. Shipped to steelmaking plants, these pellets provide raw material for the production of steel.[8] Large tailings basins store waste material from this concentration process near the processing plant or in areas conducive to its storage.

Taconite mining also involves other dimensions. A mosaic of surface and subsurface ownership patterns, global steel prices, union contracts and other labor-input factors, mined land reclamation rules, and the quality of ore available in a specific location determines how mining processes unfold on a site and what mix of ore moves to the crusher at any given hour. After converting to taconite mining, the industry moved to the eastern half of the region (Hibbing east to Biwabik) where larger pits set the scale for the enormous quantity of rock needed to obtain adequate amounts of the lower grade iron ore. When extracting taconite, mining companies must reclaim mined land to stabilize surface rock and waste stockpiles, control erosion and drainage, design stockpiles to comply with maximum lift height and bench width, supply topsoil, and revegetate surface features.[9] Taconite mining, in both its operations and in its reclamation activities, alters the geography, scale, and visual quality of the regional landscape beyond any extent imagined during the late 19th century forays for timber or iron ore. These activities—operations and reclamation—direct the design vocabulary of the partnership (Figure 3).

Cultural Context and Continuity

The culture of the Mesabi Range evolved around its rich timber and ore resources, the miners constituting a rich

diversity of immigrants from all parts of Europe.[10] Visitors to the Range can still hear Finnish, Italian, Polish, Serbian, German, and other languages, eat a variety of ethnic foods, and visit the rich remains of immigrant settlement. This century-long interaction between culture and natural processes within the context of taconite mining continues as the economic and cultural base of the Range, shaping both commodity resource values as well as significant historic, scenic, and even recreational values (Alanen 1989; Pitt, Roos, Fernandez 2003). This cultural symbiosis is unique to the Upper Midwest and even today exudes a strong economic, social, and political identity. When dealing with the rest of Minnesota, range politicians regularly remind fellow state legislators of the continued contributions of iron ore extraction to state coffers.

Mine-based locations and towns grew rapidly from the early 1900s through the 1950s but imploded in the 1960s as the demand for ore slowed (Alanen 1989). With the exception of Grand Rapids and Virginia, whose economies depended more on timber, pulp, and tourism, the regional population decreased consistently through the 1980s.[11] Today's towns still function as service centers for the mines but have become somewhat less dependent on the mines as the region's economy has slowly diversified.

Issues and Opportunities

When the Laurentian Vision Partnership began in the late 1990s, facilitated discussion with its stakeholders identified several issues and opportunities:

- Despite fluctuations in the global demand for steel, the region may be unable to sustain the mining of reserves through the 21st century.
- Mining has left a region-wide footprint of underused, unproductive land. Making way for the next generation's potentially diverse prospects will require regeneration of this landscape.
- Generations of poor relationships between mining interests and communities have resulted in entrenched positions about planning, economic development, and the predominance of the taconite industry. The partnership process has revealed the need to tolerate ideas and collaborate willingly over the long term to keep the Range a healthy region of the state.
- Local planning may be difficult given the proximity of range communities to active mining and future reserves. Communities realize that they need to understand and apply sound, up-to-date resource information to incorporate mining geography into local planning efforts and development decisions.
- Companies pay the state a taconite tax levied on each ton of ore produced.[12] The proceeds of this tax finance the development of new mining technologies, the acquisition of new mining equipment, upgrading of facilities, and new mineral exploration programs related to economic development, tourism, and mined land reclamation within the boundaries of the mining areas of the region. The region needs a larger conceptual framework for planning alternative projects so that it can realistically assess new opportunities as elements of a larger vision rather than as individual ventures.[13]
- While mining is still important to the regional economy, Rangers may no longer presume the breadth of economic prosperity provided by mineral extraction for so many decades.[14] Decision makers should begin to consider more productive end-uses that eliminate challenging and unaffordable reclamation projects, rebuild land and scenery, restore natural systems, and provide land infrastructure that can capitalize on new economic opportunities.

THE LAURENTIAN VISION PARTNERSHIP: DIGGING IN

Conceptual Approach

Successive discussions with multiple stakeholders and analyses of regional resources suggested a reknitting of the physical, biological, cultural, and civic infrastructure as a conceptual framework for rebuilding the regional landscape.[15] Central to this reknitting concept

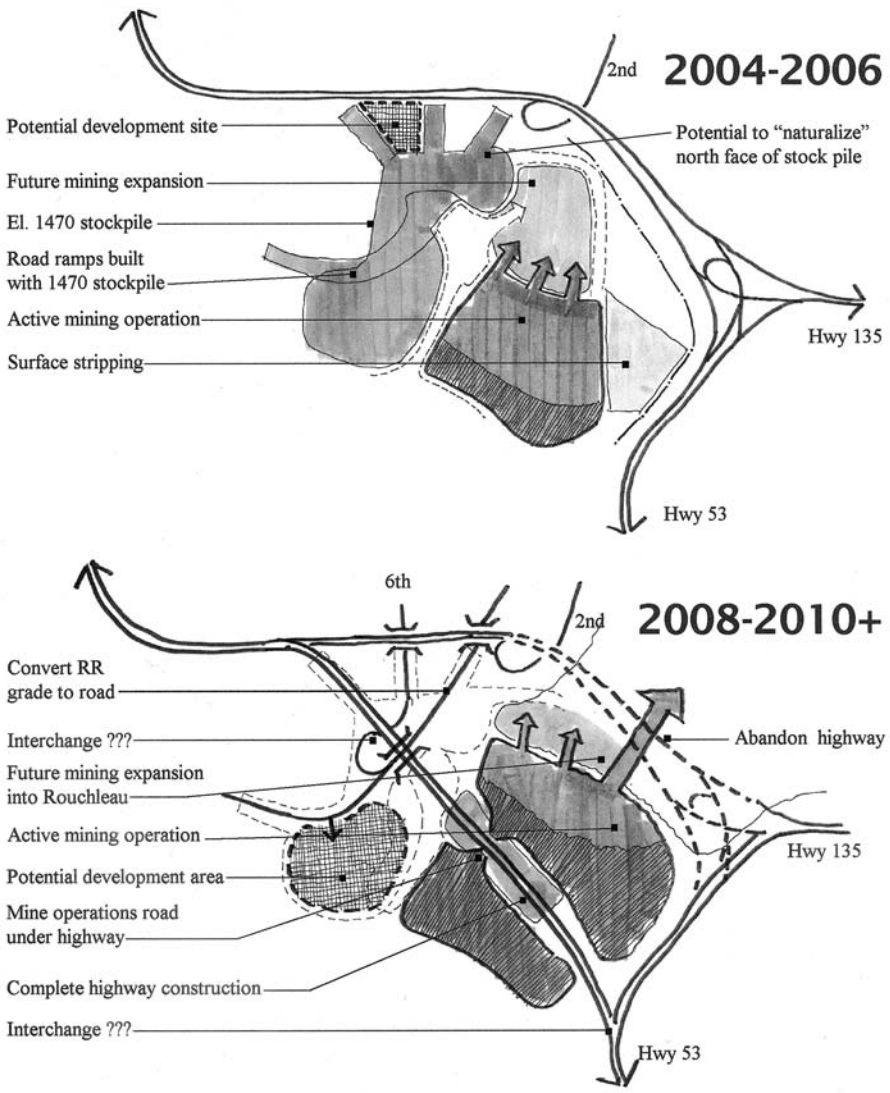


Figure 4. Two-dimensional diagrams developed as thinking tools helped the partners to study and explore the mining process and its inherent opportunities and constraints. The diagrams quickly translate to stakeholders the physical and temporal sequence from mining infrastructure to landscape infrastructure using community and industry goals and landscape architecture design principles (Virginia Design Charrette).

is the assumption that mining can reshape land and water to meet multiple goals for productive and attractive end uses. If integrated early enough into mine plans and overall operation and if all parties agree, reknitting may be achieved at little or no additional expense (Figure 4).[16]

Large reserves of undeveloped forest and wetland remain intact north and south of the Laurentian Divide, providing significant habitat values for forest and wetland plants and animals (Tester and Keirstead 1995). Historic patterns of mining have fragmented these resources. By reconstructing important hydrologic regimes, habitat systems, and vegetation communities, future mining could link or reknit resources north of the divide with those located to the south. Graduate level, regional landscape design studios at the University of Minnesota (the university) explored this concept, producing several regional scale design and planning strategies (for example, a regional heritage corridor—or Avenue of the Mines—community greenways, and conservation reserves) (Pitt, Roos, and Fernandez 2003). Each strategy used active mines and/or a cluster of abandoned mines and surface mine artifacts as structuring elements of the larger planning framework. Though the concepts and their possibilities excited industry and business interests, local and regional governments took no action. The challenge was to organize advocates and stakeholders around these possibilities.

Organizational Approach

Armed with this conceptual framework, the authors began meeting with key stakeholders in 2000 to obtain information about the region and to share previous discussions with USS representatives. Stakeholders,

especially state government, utility, and industry interests, were suspicious of the university and its association with any USS agenda. Several Range interests were unable or unwilling to think about the future of the region beyond mining, and they believed doing so within a large scale participatory process was not a proper function of the university. At the same time, the university, wishing to diversify its client base beyond USS, believed the project to be a powerful opportunity within its outreach mission to benefit the citizens of the state. While the partnership was eventually established, understanding mining as a process that could facilitate a new future for the region was not, for some, an embraceable vision or organizing concept.

Tools and Strategies

As a result of the caution exhibited by some stakeholders, the Laurentian Vision partners employed informational strategies and a variety of engagement techniques to maintain stakeholder interest, build capacity within the partnership, and explore the future end-use potential of active mines. Several key tools helped the partnership increase understanding of, interest in, and acceptance of contemporary mining as an essential catalyst for the long-term vitality of the range.

Partnership coordinating meetings. The coordinating meetings of the Laurentian Vision Partnership were the nerve center for overall project conceptualization and operation. During the seven plus years of initiating, implementing, and institutionalizing the collaborative land design process, 27 partnership meetings served as a low overhead, administrative structure for planning, steering, coordinating, evaluating, and developing the effort.

Funded in the same potluck style as for other partnership activities, the meetings occurred every one to three months. Each partner organization financed the travel and time costs of its representative(s). The partnership also made a commitment to a consensus decision making strategy. Each meeting was custom designed to assure meaningful and productive transdisciplinary dialogue and decision making by a diverse and constantly changing group of stakeholders representing various interests, knowledge bases, skill sets, perspectives, power bases, and expectations.

At the first six meetings, core partners formed consensus about the project scope, intent, and goals, and agreed to basic operating, coordinating, and funding mechanisms. This first step was simple, but not easy to accomplish. The key challenge was to build trust among the key players (landscape architects, planners, public sector resource management professionals from multiple levels of government, mining company officials, utility companies, financial institutions, and regional and local community leaders) so as to gain support for identifying and mobilizing the mission of the project. A commitment to the social construction of new understandings of, and new policies for, guiding the range's future emanated from these first few meetings.

The partnership subsequently sponsored 17 additional meetings to mobilize its mission and goals by developing collaborative land design tools and a three-year work plan. The meetings also demonstrated the power of design charrettes and broadened awareness of Laurentian Vision resources.

Finally, from August 2002 to March 2005, old and new partners developed an institutional framework for making the partnership a sustainable decision making resource on the range. They identified strategies for delivering tools and resources, targeting priority projects, and facilitating regional visioning for land design that would accommodate multiple interests and uses. The partnership obtained local and regional funds and people to manage the activities and continued to utilize external expertise in land design thinking and charrettes as needed. Specific achievements emanating from partnership activity from 1999 to 2007 include the development and distribution of an atlas of regional and site-based information for shaping the Range landscape and the conducting of three design charrettes in communities across the Range as well as land shaping design workshops for mining engineers.

Professional facilitator. A professional facilitator (co-author Marja Hansen) with extensive expertise in environmental initiatives and consensus building across Minnesota helped create and implement the overall process used in developing the partnership and the land design process. She led all 27 work sessions and some wrap-up stages for the charrettes. Her involvement was critical in providing a systematic and civil process for the discussion of issues and development of goals and decisions. She was also critical in ensuring broad participation from local communities and from key stakeholders (especially nontraditional interests who rarely attend participatory sessions of any kind) and in maintaining neutral settings for discussion. The facilitator was key to sustaining transdisciplinary discourse and to constructing of new understandings among the various sectors and communities involved in the partnership's activities.

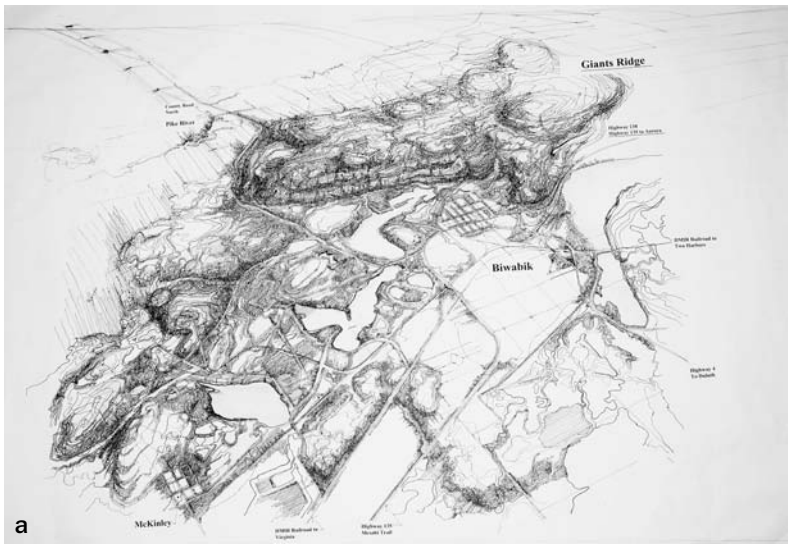
Regional resource atlas. Information compiled in an atlas included basic data describing biophysical and sociocultural characteristics of the range and its communities as well as working maps illustrating the location of past, present, and future ore reserves. Produced as a paper document as well as a navigable CD-ROM, the atlas contained accompanying user instructions written to allow citizen, as well as professional access to the data.

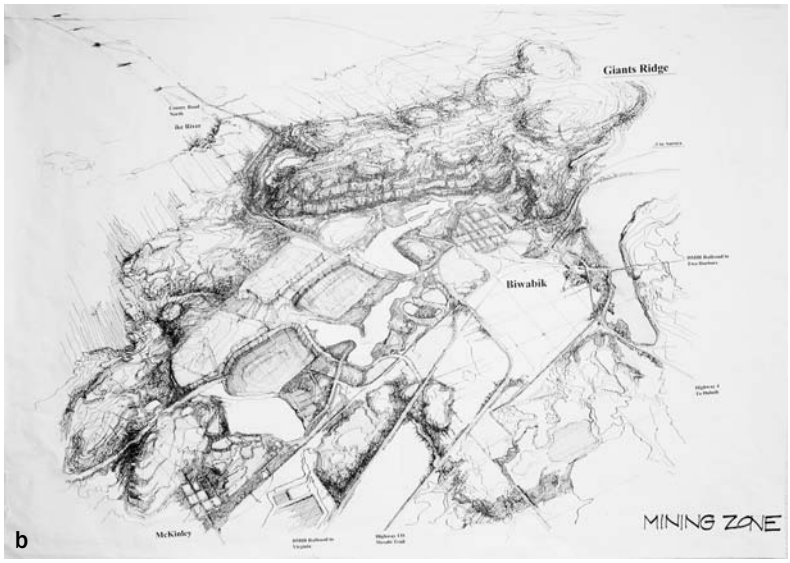
Technical work groups. The partnership organized technical work groups early, to define the boundaries of the physical study area,[17] develop and coordinate the mineral reserve database with mine companies, develop criteria for project sites, and craft an outreach strategy. Today, three work groups continue to coordinate access to geographic information systems (GIS) data, communicate partnership activities across the Range, and develop potential land design candidates with mine companies, fee holders, and other key stakeholders.

Land design process. The partnerships applied a land design process to stakeholder decision making in *design charrettes* (*share-its* in range language) to study and illustrate realistic land designs for active mine sites once they are depleted. The well planned and staffed charrettes also laid out short and long-term implementation actions and responsibilities for development, should the designs become reality. Previous to partnership activities, charrettes were not a common occurrence on the Range, especially with mining companies and communities. They have proven a meaningful, credible way to represent the partnership and to demonstrate visually the opportunities mine sites provide. Company and community interests now use charrettes as a workshop format.[18] Participants of the original charrettes included multidisciplinary teams of local and national design, engineering, planning, and natural resource professionals, who quickly grasped the complexities of mine design and who could provide unbiased design and planning recommendations. Several individuals participated in more than one charrette.[19] While there have been some questions about using outsiders on charrette teams, the majority of Rangers participating in the charrettes have been more than enthusiastic about the involvement of outside professionals.

Three major design charrettes have taken place in various locations on the Range since 2001.[20] Each charrette focused on a specific issue and the relationship between a Range community (or group of communities) and an adjacent active or future mine. The identified issue highlighted some condition the community wanted to resolve either in relationship to, or because of, the mine's operation. Tying the charrettes to specific community issues related to the mine's operation helped the community prepare concept plans in agreement with the involved company's operation and schedule.

All of the charrettes demonstrated, through maps, computer simulations, and especially through drawings, how an active mine site works and how mining can shape future land to meet community needs (figure 5). They also illustrated how to reknit, where possible, hydrologic processes, vegetation, and habitat across the range. Each charrette specified earth moving operations,





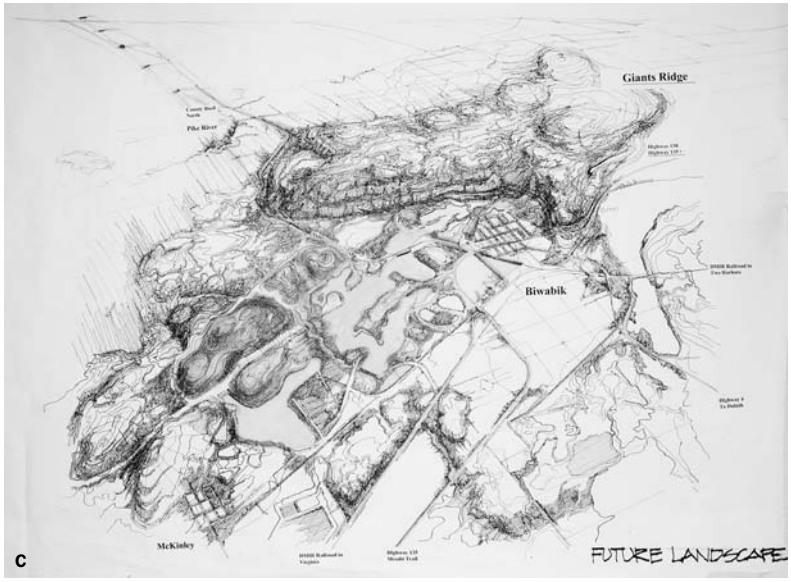


Figure 5a, b, and c. Aerial perspectives illustrate and describe the transformation from current mining operations to future usable landscapes. The drawings vividly communicate to stakeholders the spatial and cognitive relationships between mining and land design and help them rethink the shape and function of future places on the Mesabi iron range (Courtesy of James Pettinari).

calculated volumes of earth to be moved, laid out the specific steps and timelines needed to undertake development scenarios, and identified the parties responsible for short- and long-term implementation.

The charrettes produced two interesting results. First, participating mine engineers demonstrated strong problem-solving skills, good design sense, and the capacity to be team members capable of addressing community issues.[21] Hence, their stature within participating communities increased. Second, visualization techniques, especially drawings, were critical research tools helping all parties to understand the three-dimensional complexities created by mining as well as the opportunities afforded by future mining operations.

Charrette teams intentionally included professionals with expert drawing and graphic skills in their membership. Their ability to produce understandable diagrams, sections, plans, and sketches quickly and clearly illustrating how a mine can shape earth into a future asset or amenity was influential with the mining companies, agencies, communities, and key landowners (Figures 4 and 5). All of the partners now understand this visual language and the spatial consequences of mining that affect the larger areas surrounding the mines. Use of the visual language of the design charrette continues in other Laurentian Vision projects.

Mine course. Preparing the next generation of mine engineers to undertake land design is an integral part of mine planning and mine operations. Such a task has been a longstanding goal of the partnership.[22] From 2007 to 2009, the authors developed a course for mine engineers on shaping land.[23] The course, *Land Design Opportunities in Taconite Mining: A Land Shaping Workshop,* examined the land design process with almost 40 senior and junior mine engineers representing every taconite company in the region as well as Minnesota Department of Natural Resources (MnDNR) land reclamation specialists and Iron Range Resources (IRR) staff. Taught in intensive two-day workshops, the course explored how to rebuild natural process infrastructure and how mine features (pit walls and edges, stockpiles, haul roads, terraces, and so forth) could be shaped into attractive, productive land, using thoughtful site planning and visual design devices. Seeking the creation of alternative future land use scenarios, participants also worked as teams to model land shaping on active mine sites in the region, both in pit and stockpile development.

The course was popular with participants and has resulted in three current demonstration projects initiated and implemented by mine engineers with the authors.[24] These projects explore alternative grading and revegetation concepts for overburden and waste rock stockpiles in locations highly visible to residents and the public. The projects clearly reflect a change in the companies' perspectives about their role in reclamation efforts as well as a willingness to collaborate with partners to produce a better outcome for the region's landscape.

RESULTS AND REFLECTIONS

Results

After a decade of hard work, the partnership's mission and goals have advanced through small, tangible moves. For example, the previously mentioned regional resource atlas, which provides comprehensive resource information about the Range, was integrated into the MnDNR GIS system, is available to all Range communities, and continues to be updated by the MnDNR's Division of Lands and Minerals. Through a cooperative agreement with the partnership, the Arrowhead Regional Development Commission (ARDC), the region's planning agency, now provides technical assistance to range communities in the application of the data to community planning, an important activity described in the 2002 work plan.[25]

Shaping the working landscape, reknitting community. In light of renewed mining development, reserving land that sustains current and future mining has become an important component of the partnership's reknitting framework, especially since it is linked with

the potential of active mines to generate end-uses that promote economic sustainability and the rebuilding of natural processes. Recognizing that a postmine site is still a landscape with the potential for value-added use represents an important shift in mindset. Such a multiobjective understanding of and approach to land has helped range communities rethink locations for potential development, often with a much more sustainable idea in mind. Communities have received funds from the state legislature, MnDNR, IRR, and regional foundations to study environmental issues in anticipation of such development possibilities. This perspective has also helped mining companies consider the possibility of integrating future land scenarios into active mine plans.

The transdisciplinary and prospective nature of the new approach to the postmine landscape changed the thinking of mining companies about a mine's end use and the companies' role as a community partner. It also changed community attitudes toward mining companies. USS, Cliffs Natural Resources, and ArcelorMittal engineers are more willing to explore how and what to build as infrastructure for future end-uses. For example, mine land reclamation requirements are specific relative to erosion control, drainage, and stability, but latitude exists in their on-site execution. In addition, longer reclamation planning horizons allow key partners to envision and embrace land shaping opportunities that may take more than the typical five-year mine permit process and require a broadening of the mining company's perspective. The shift in thinking about the value of the mine—that it is not just about the mineral being extracted but also about postmine real estate—has helped company and fee-owner interests to become more interested in how mining can create new land and contribute to higher quality visual landscapes and natural systems resilience throughout the region. The new mindset has created a foundation for the reknitting of communities and the regional landscape.

Each design charrette has confirmed the value of sustained participation in making an active civic infrastructure. The best land design information, tools, and expertise mean little without the interest, political will, and commitment of local involvement. At the local level, the design charrettes confirmed the key roles of landowner, fee owner, mining company, and community stakeholder in affecting the quality of conceptual and planning outcomes. It took almost a year to cultivate formal buy-in by the core regional partner organization. The existence of that social capital mobilized technical, financial, and other resources and the Laurentian Vision process became a reality on the land. The fact that the partnership's criteria for selecting new charrette projects now include four community ownership factors as well as three physical site criteria reflects the importance of these social dimensions to the concept of reknitting.[26]

Partnership in both Range nomenclature and practice. Regardless of how it is formally exercised, partners have adopted a collaborative mindset as the way to do business. In the past, adversarial relationships between communities and mining companies were standard practice. Today, there is interest on the part of both parties in working together to investigate development opportunities on mine lands adjacent to towns and to avoid expropriation of future mineral reserves by land use decisions, especially in the central and eastern Range. The partnership is now a legitimate forum for discussion of a variety of issues related to mining and community development. Tangible communication links are now coordinated via regional sub groups and the IRR, the quasi-governmental agency charged with offsetting the impacts of mining with economic development in the region. A partnership mindset is also evident in some local planning efforts.

Discussion

Do the conceptual and organizational approaches of the partnership and the application of toolkits of interventions—namely the design charrettes, training workshops, and multidisciplinary design work sessions

focused on specific mine sites reflect TDAR as defined by Stokols and interpreted by the authors? While the project is not wholly transdisciplinary, the authors believe it is moving toward TDAR in four fundamental ways:

1. Social construction of new knowledge base
2. Willing commitment on the part of core partners to work together equitably over time
3. Strategic applications of the types of collaboration outlined by Stokols as a way to work through individual projects, cultivate a long-term view of the region's landscape, and sustain stakeholder participation
4. Management of a long timeframe through understanding of the fundamental values underlying the partnership's goals

New knowledge. When the Laurentian Vision began, the purpose of the project and the role of the university were to facilitate a vision of the region as a nonextractive landscape. As the authors obtained and used new information about the mining industry, the culture of Range communities, the ways that Rangers conduct business among themselves, and the politics of the mine economy—and as stakeholders discovered from the authors new ways of seeing the landscape as a product of mining operations—knowledge collectively increased and changed mining processes. For example, after mine engineers learned and examined certain landscape architecture, visual perception, and land suitability principles during the 2009 training workshops, they quickly adapted them to existing mine operations. In the process, they identified several locations across the region suitable for application of these principles. The authors' ability to translate these principles into the context of a mining operation and the engineers' acceptance and use of them as valuable reshaping concepts resulted in three current demonstration projects. The projects will explore how mine engineers and agencies can rethink and apply reclamation planning and design standards.

Application of landscape architecture theory and design principles has also expanded the partnership's vocabulary and the way in which partners speak about the region's landscape. For example, the phrase "from pits and piles to lakes and landscapes," a pithy slogan the authors used years ago to characterize a future landscape and clarify the goals of the Laurentian Vision, now serves as the logo for the project. Mine engineers also use such terms as "visually unacceptable" to describe the location and shape of surface stockpiles. Engineers help plan and design the land shaping strategies needed to improve the fit of stockpiles in the landscape.[27] "Value-added" and other phrases that convey the notion of the landscape as multilayered and rich with potentially renewable assets other than minerals are becoming common descriptors in agency, community, and industry materials. This share-it language reflects an expanded knowledge base that is beginning to enrich a picture of the Range landscape and an ability to convey this image using descriptors different from those familiar to the lexicon of any one interest

Willing commitment. The development of trust among the individuals in the partnership and an evolving respect for the multiple disciplines represented there has taken several years, requiring conscious attention and intention. "Persistence, persistently applied"[28] has maintained partner interest and repeatedly spurred them into trying new ideas in unfamiliar formats (for example, design charrettes and site-based collaborative work sessions) to develop solutions more comprehensive than any single partner discipline could generate. This connection between partners, built over time and through respect for and acknowledgment of skills and tolerance for perspectives, has not only maintained the dynamic of the partnership but also motivated partners to follow through with each other in action. Responsibility to every partner is now part of the meaning of the true collaboration phrase written into the original Laurentian Vision goals. This type of commitment to working together has changed partners' perceptions

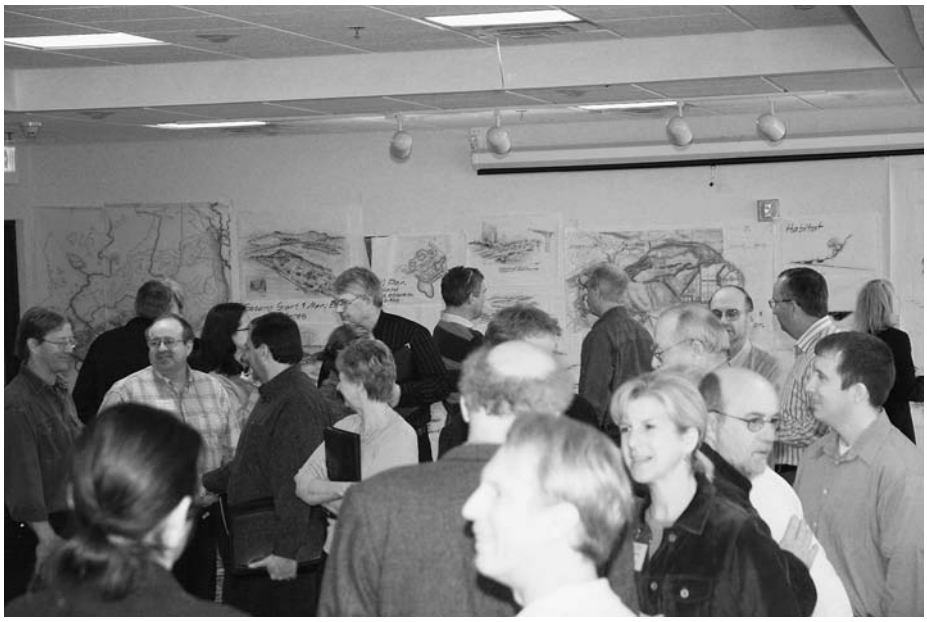


Figure 6. Partner use of appropriate collaborative types in the right context builds civic and political capacity in an ever-expanding organizational scope that can apply new land-design strategies to community and industry settings (Courtesy of Iron Range Resources).

and expectations about the Laurentian Vision and the way of doing business within its context—a transformation in intent and in the responsible application of new knowledge.

Strategic collaboration. Since a fundamental goal of the Laurentian Vision Partnership is to "build true collaboration among interests," each project presumes collaboration, or a contextual *we,* during all project phases, regardless of how project-specific collaborations have evolved (Figure 6). Meaningful involvement with an incentive to continue, expert facilitation, and small incremental moves have softened overall reactive "us-against-them" positions common to the beginning of the initiative as well as facilitated development of a sliding scale of collaborative types. Partnership activity has involved use of interdisciplinary and multidisciplinary collaboration involving community and lay perspectives across governmental levels. The ability of partners to strategically use the right types of collaborative action at the right times has moved the project process toward, in Stokols's words, "transdisciplinary action."

Management of time. The long-term vision behind the Laurentian Vision Partnership is to rebuild the region's physical landscape in ways that can facilitate a healthy, diverse, and sustainable future. Two important factors appear to be working to manage this momentum in the short term: First, the partnership genuinely appreciates the Range as a physical and cultural place, uses consensus building and collaboration among core partners as an organizational tool, and persists in any effort, regardless of context, to maintain original project intent and to help new partners understand the partnership's focus. Second, the partnership develops and implements projects that advance small but important ideas (often the products of new shared knowledge) about the long-term reusability and value of the region and provide professional recognition of partners' efforts that maintain their technical and political interest.

Current training workshops help mine engineers and other partners, including landscape architects, improve their existing skill sets in new contexts and integrate new thinking (for example, landscape architecture theory and practice) into mine, community, and agency practice. Design charrettes allow communities to explore long-term goals and provide mining companies with an opportunity to stay involved with their neighbors. Demonstration projects allow mine engineers and landscape architects to explore new technical and design solutions that result in products that document new thinking about land shaping, provide physical models that may be replicable on other sites in the region, and inform new processes of landscape architecture.

In the long term, both the partnership's ethic and its ability to generate incremental projects across the region seems positioned to help all partners move fluidly between their roles as planners, designers, facilitators, project organizers, and managers as business

conditions and political climates shift and the imperatives for the integration of action research increase across the complexity of events.

ACKNOWLEDGMENTS

This article draws heavily on current and archival project documentation of the Laurentian Vision Partnership from the past 13 years. The authors gratefully acknowledge the many industry, business, community, government, university, foundation, organization members, and students who have contributed to and still participate in the Laurentian Vision Partnership. Their support of its mission and their loyalty to its incremental implementation keep it alive. We are also grateful to the editors of this paper for their guidance and assistance and to the reviewers for their interest and suggestions.

NOTES

1. Jim Swearingen, General Manager, USS Minnesota Ore Operations; Dennis Hendricks, USS Property Manager, Upper Midwest region; Bruce Kniivila, Area Manager, Mine Engineering and Development, Minnesota Ore Operations; Larry Salmela, Director, Environmental Engineering, Minnesota Ore Operations. University of Minnesota Department of Landscape Architecture faculty members at the meeting included John Koepke, Bob Sykes, David Pitt, and Lance Neckar. Darrell Meyer of the KPS Group and a retired landscape architecture faculty member from Auburn University facilitated the meeting. Meyer helped facilitate a development project with USS and the City of Birmingham, Alabama.
2. Because mining in northern Minnesota extracts iron ore from a silicon matrix, the process is relatively benign in terms of its water-quality implications.
3. Members of the Minnesota Iron Range state delegation, the University of Minnesota's Department of Landscape Architecture, and private mining companies initiated the Laurentian Vision in the late 1990s. Today, the partnership includes MnDNR; IRR; MN Power; USS Minnesota Ore Operations; USS Keewatin facility; Cliffs Natural Resources; ArcelorMittal Steel USA; National Steel Pellet Company; Northshore Mining Company; Meriden Engineering; Eveleth Fee Iron Mining Association; Range Association of Municipalities; St. Louis County; Itasca County; the University of Minnesota Natural Resources Research Institute and Department of Landscape Architecture; USX Foundation; Northland Foundation; Blandin Foundation; The Virginia Foundation; Chisholm Foundation; City of Biwabik; City of Hoyt Lakes; City of Virginia; City of Eveleth; Virginia Economic Development Authority; Virginia, Gilbert, and Mountain Iron Chambers of Commerce; Quad Cities Area Alliance; Minnesota Department of Transportation; City of Hibbing; City of Chisholm; Balkan Township; Central Iron Range Initiative; and the Western Mesabi Mine Planning Board.
4. Mineral and land relationships are three-dimensional. Ownership may relate to surface land, ownership of minerals below the surface, or both. Often ownerships are mutually exclusive; mining companies may be landowners and/or lessees.
5. The shape and color of this surface landscape is a product of geology, Minnesota reclamation standards, and mining processes.
6. According to IRR, every three minutes approximately 240 tons of rock is loaded onto a mine crusher and processed into taconite pellets. Mining moves between 160 and 200 million tons of rock annually in Minnesota to fabricate taconite pellets. As of 2008, these companies were producing taconite on the Mesabi Range:

ArcelorMittal Steel USA	2,787,248 tons
Hibbing Taconite Company (Cliffs Natural Resources)	8,220,000 tons
United Taconite LLC (Cliffs Natural Resources)	5,346,442 tons
Minnesota Ore Operations (US Steel)	14,369,363 tons
Keewatin Taconite (US Steel)	4,550,250 tons
Northshore Mining Co. (Cliffs Natural Resources)	5,326,000 tons

7. Three examples of new mining technology on the Range are that of (1) Minnesota Steel, a state-of-the-art steelmaking plant under construction in Nashwauk, which will be the first iron-ore mining, processing, and steelmaking complex on a single site in North America; (2) Mesabi Nugget, located in Hoyt Lakes, the first commercial-demonstration nugget plant, which began producing nuggets in January 2010; and (3) Polymet, a Canadian corporation, which is in the process of acquiring permits for a copper, nickel, cobalt and precious-minerals mine on the site of a former taconite-processing plant on the eastern part of the Range.
8. Minnesota Steel's fabrication plant in Nashwauk will eliminate the need to transport pellets from the region.
9. Minnesota reclamation standards govern the land used in mining. Standards cover the placement of in-pit mine

waste, minimization of water and air pollution, and the compatibility of mining operations with adjacent land uses and surrounding terrain. The standards also prescribe vegetation cover, soil requirements, a timetable for 90 percent vegetation coverage, the scale and stepped form of surface stockpiles, and the character and stability of pit walls (Mine Reclamation Program 1969).

10. For information on immigration to and within northern Minnesota, see Holmquist (1981).
11. A 1984 University of Minnesota report estimated that more than 10,000 people on the Range lost their jobs in the 1980s because of the decline in the steel industry (Alanen 1989).
12. The taconite production tax rate from 2001 to 2003 was $2.103 per ton of iron-ore concentrate produced. Annual adjustments for inflation using the implicit price deflator for gross domestic product began in 2004. For direct reduced ore, there is an additional levy of three cents per gross ton for each 1 percent that the iron concentration in ore exceeds 72 percent when dried at 212 degrees F.
13. A good example of an individual project that did not meet expectations is the Minnesota Discovery Center, an interpretive and research facility located in Chisholm. IRR built the Center in the 1970s as a "premier world-class museum" to document the region's rich mining heritage and attract economic development to the central iron range. It includes an indoor museum, a reconstructed Glen Location, an outdoor interpretive area (Heritage Park), a veteran's memorial, and a seasonal trolley ride around a historic open-pit mine. It also houses the Iron Range Research Center, a library and archive supplying some of the most important genealogical source material in the Upper Midwest. The facility never achieved its vision and visitation rates and spin-off development did not materialize. The facility closed briefly in early 2010 and is now subsidized by IRR.
14. The Ironing Mining Association of Minnesota (IMA) states that taconite mining contributes approximately $1.5 billion per year to the Minnesota economy in the form of purchases, wages, taxes, royalties, and benefits. According to economist Thomas Michael Power (1996), the service sector has become the economic engine of the region, producing relatively high-paid jobs, while the mining industry continues to lose economic influence. This may change with the recent renaissance in mine development. Power states that in-migration is partially influenced by how attractive places are. He states that mining companies make the Range an unattractive place to live because of the scale of defacement (Hemphill 2007).
15. *Reknitting* is a term coined by the authors and other departmental faculty to characterize the reconnection of multiple systems and places across the Range.
16. Anthony (Tony) Bauer used the phrase *land shaping* during initial Laurentian Vision meetings with mine engineers and company managers. While the phrase is neither a new term nor an original concept—Kenneth Schellie developed the concept of land shaping from postmine lands (Schellie and Rogier 1963)—it has registered with industry interests as both a positive *and* noncommittal term to use in exploring Laurentian Vision goals.
17. The discussion of study-area boundaries among partners ranged from the need to identify specific reserve boundaries to the maintenance of fuzzy reserve geographies to protect proprietary company information. Inclusion of current reserve locations in the MnDNR GIS system supports Laurentian Vision planning efforts and decreases the potential for community plans that will not receive industry or public support.
18. USS recently used the Laurentian Vision land-design charrette process to explore large-scale residential development concepts in northern Minnesota.
19. Team members included landscape architects and architects Jason Aune, Tony Bauer, Christine Carlson, Josh Cerra, David Chimielewski, Jerry Dombek, Steve Durrant, Bill Everett, Carlos Fernandez, Todd Halunen, John Koepke, Roger Martin, Steve Mekkes, Steve Moddemeyer, Erik Mustonen, Dennis Oost, James Pettinari, Kathryn Ryan, Jerry Shapins, Mike Thomas, and Fred Young.
20. EVTac Mining Company and Quad Cities charrette, 2001; Hibbing Taconite, USS Steel MinnTac, and Cities of Hibbing and Chisholm, 2003; ArcelorMittal USA and the City of Biwabik, 2007.
21. Participating mine engineers to date have included Jeff Hammerlind (EvTac), Bill Everett (Hibbing Taconite), Pete Vandelinder (Cliffs Natural Resources), Jerry Dombek (USS Minnesota Ore Operations (MinnTac), and Steve Mekkes (ArcelorMittal).
22. The 2002–2005 Laurentian Vision work plan included land-design training for mine engineers as a high priority.
23. The Iron Ore Cooperative Research Grant Program, established in 1999 by the Minnesota Legislature to foster iron-ore and environmental cooperative research efforts, funded the development and administration of the course.
24. The authors are currently working with Cliffs Natural Resources and USS mine engineers on the three demonstration projects. Participating company mine engineers and

environmental specialists include Julie Elkington, Terry Fillippi, and Larry Schmelzer.

25. The Division of Lands and Minerals had begun to acquire proprietary mineral and reserve data from mining companies. It received company permissions to integrate the data into its larger MnDNR GIS system for public use as part of the partnership's 2002–2005 work program.
26. Guidelines for selecting appropriate charrette sites include three physical site factors: land-use focus including mining and other resources, availability of critical resource planning information for land design, and physical resource skills available in community to assist partnership—as well as four community ownership factors: critical need or opportunity requiring attention and action in a community, demonstrated local community commitment, multiple local stakeholders willing and ready to collaborate, and local and other funding available for planning and follow-up.
27. A recent video produced by IRR presents a mine engineer describing one of the current demonstration sites using Laurentian Vision nomenclature. See Bloomquist (2010).
28. The phrase was adapted from "endless pressure, endlessly applied," a slogan popularized in the early 1980s and still used by Brock Evans, president of the Endangered Species Coalition.

REFERENCES

Alanen, Arnold. 1989. Years of change on the Iron range. In *Minnesota in a Century of Change,* ed. Clifford E. Clark Jr., 155–194. St. Paul: Minnesota Historical Society.

American Society of Landscape Architects. 1978. *Creating Land for Tomorrow, Landscape Architecture Technical Information Series*. Washington, DC: American Society of Landscape Architects.

Bauer, Anthony M. 1982. *Shaping Landscapes for Tomorrow*. Alexandria, VA: National Stone Association.

Bauer, Anthony M. 2000. *Reclamation Planning of Pits and Quarries, Landscape Architecture Technical Information Series*. Washington, DC: American Society of Landscape Architects.

Bloomquist, Lee. 2010. Uniquely-shaped stockpile is vegetated through partnership. *RangeViews*. http://ironrangeresources.org/rangeviews/2010/07/01/uniquely-shaped-stockpile-is-vegetated-through-partnership/ [July 15, 2010].

Clark, Clifford E., ed. 1969. *Minnesota in a Century of Change.* St.Paul: Minnesota Historical Society.

Davis, Edward W. 1964. *Pioneering With Taconite*. St. Paul: Minnesota Historical Society.

Hemphill, Stephanie. 2007. New Report Questions the Value of Iron Range Mining Jobs. Minnesota Public Radio, October 8, 2007. http://minnesota.publicradio.org/display/web/2007/10/08/miningimpact/ [July 15, 2010].

Holmquist, June Drenning, ed. 1981. *They Chose Minnesota.* St. Paul: Minnesota Historical Society.

Mineland Reclamation Program. 1969. Minnesota Statutes Sections 93.44–93.51, http://www.lawserver.com/law/state/minnesota/mn-laws/minnesota_laws_title_21_chapter_93 [July 15, 2010].

Pitt, David G., Steve Roos, and Carlos Fernandez. 2003. *Green Infrastructure Systems and Regional Land Use Planning.* Minneapolis: University of Minnesota.

Power, Thomas Michael. 1996. *Lost Landscapes and Failed Economies.* Washington, DC: Island Press.

Schellie, Kenneth, and Anthony M. Bauer. 1968. *Shaping the Land: Planned Use of Industrial Sand Deposits.* Silver Spring, MD: National Sand and Gravel Association.

Schellie, Kenneth, and David Rogier. 1963. *Site Utilization and Rehabilitation Practices for Sand and Gravel Operations.* Silver Spring, MD: National Sand and Gravel Association.

Stokols, Daniel. 2006. Towards a science of transdisciplinary action research. *American Journal of Community Psychology* 38 (1–2): 63–77.

Tester, John, and Mary Keirstead. 1995. *Minnesota's Natural Heritage: An Ecological Perspective*. Minneapolis: University of Minnesota Press.

University of Minnesota. 1995. *A History of the Land*, a four-part documentary series DVD. Minneapolis: University of Minnesota College of Natural Resources and Twin Cities Public Television.

Winchell, Newton, and Horace Winchell. 1891. *Geological and Natural History Survey of Minnesota, Bulletin No. 6: Iron Ores of Minnesota*. Minneapolis: Harrison and Smith.

Zube, Ervin. 1966. A new technology for taconite badlands. *Landscape Architecture Magazine* 56 (2): 136.

AUTHORS M. CHRISTINE CARLSON is a Senior Fellow and adjunct faculty member of the Department of Landscape Architecture, University of Minnesota. She holds an MA in medieval studies from the Centre for Mediaeval Studies, University of Toronto, and an MLA from the University of Washington. With more than 25 years of public and private experience in conservation design and planning, facilitation, natural- and visual-resource and cultural-landscape analysis, and teaching, she serves on

the board of The Waterfront Center and was national jury chair for the 2008 Waterfront Center Excellence on the Waterfront Awards. She has been involved with the Laurentian Vision Partnership since 1998.

JOHN A. KOEPKE is Associate Professor in the Department of Landscape Architecture, University of Minnesota. He holds an MLA from the University of Washington. John has more than 25 years of academic and private practice experience with emphasis on the integration of culture and ecology in design and planning. He is of Ojibwe heritage, and his primary scholarship focuses on the design of ancient Native American settlements and the development of contemporary Native American cultural facilities. He has been involved with the Laurentian Vision Partnership since its inception in 1997.

MIRJA P. HANSON holds an MBA from the University of Minnesota, a PhD in Education from the University of St. Thomas, where she is a member of the adjunct faculty. She has 35 years of research and consulting experience in facilitation, community development, multiple-stakeholder decision-making, policy consensus-building, interorganizational partnerships, and strategic planning. Her most recent publication is *Clues to Achieving Consensus: A Leaders Guide to Navigating Collaborative Problem Solving* (2005). She served as facilitator of the Laurentian Vision Partnership from 2000 through 2004 and in 2010 was named Honorary Consul General of Japan in Minneapolis by the Japanese Foreign Ministry.