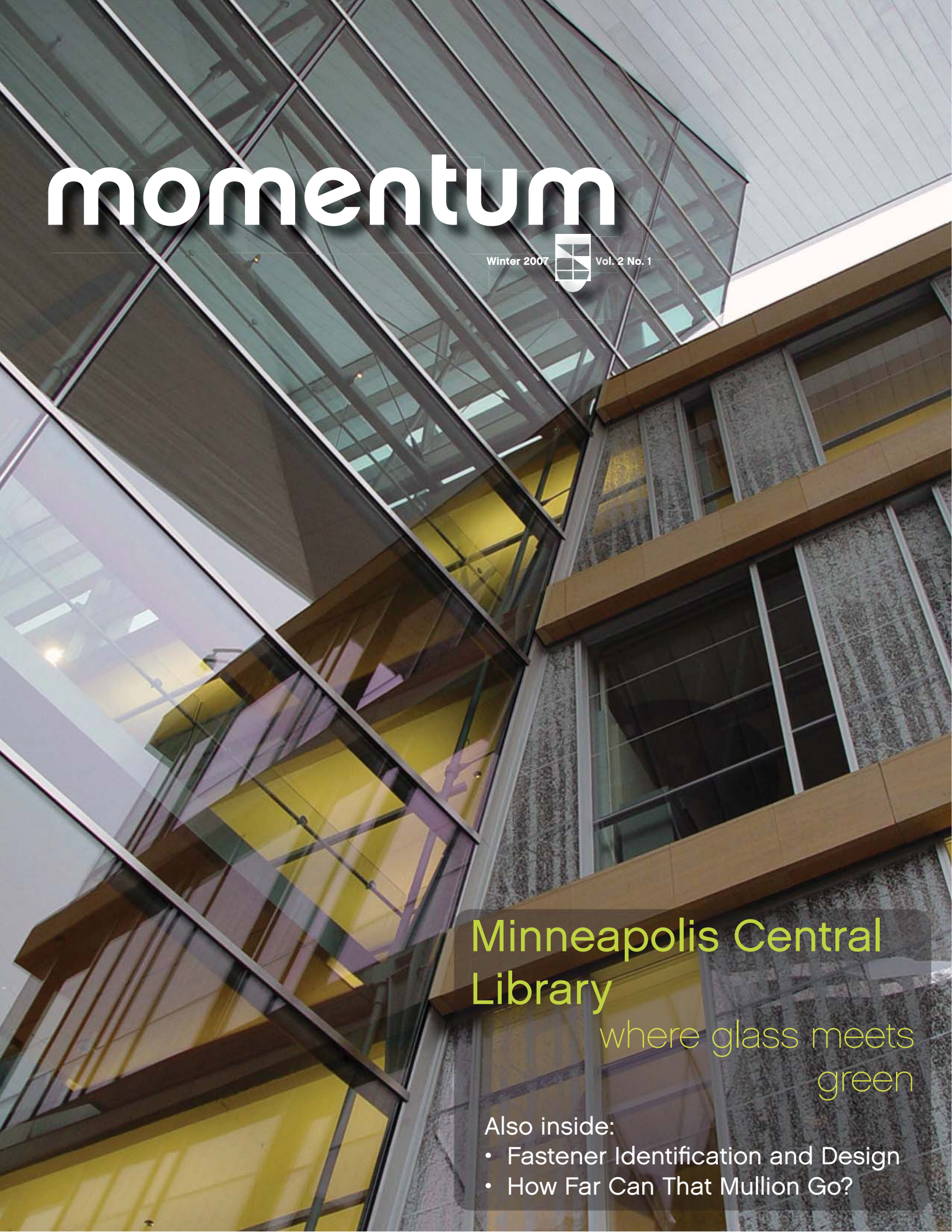

momentum

Winter 2007 Vol. 2 No. 1

Minneapolis Central Library

where glass meets green

Also inside:

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- How Far Can That Mullion Go?

momentum

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Kevin is a Project Manager and has worked in the MN office for 4 years. His favorite vacation spot is Taipei, Taiwan.

On the Cover

Minneapolis Central Library | Minneapolis, MN

Mission Statement

Through teamwork and engineering expertise we will provide effective, customized design solutions while enhancing relationships with our clients.

Opening Notes

Another year is here and so is the next issue of Momentum.

The past few months have been an exciting, transitional time here at Larson Engineering, Inc. Did you notice the name change? Larson Engineering of Minnesota and all of our other offices are now Larson Engineering, Inc. In an effort to provide a unified corporate image you will notice some more changes over the coming months.

The next major change occurs to our email addresses. The official email addresses are now identified by (first initial)(last name)@larsonengr.com. As an example, my new email address is **ksmith@larsonengr.com**. All email addresses will work for the next 6 months, but update your databases accordingly. After July, the @larsonmn addresses will cease to work. Later in the year, look for changes to our website as well.

Larson Engineering, Inc. strives to provide quality engineering services to you, our clients. Inserted in this issue is a client survey with a self addressed stamped envelope for return. An email copy of the survey will also be sent. Please take the time to respond so we may serve you better. Also, feel free at anytime to email your questions or suggestions.

My best wishes to you, your families and businesses in 2007.

Kirk V. Smith

Momentum is produced and published by the Minnesota office of Larson Engineering, Inc.

Questions or comments? Please email them to momentum@larsonengr.com.

Capstone Project

Bruce Grandits

Larson Engineering has sponsored the Capstone Project, a senior design project at the University of Minnesota, for the past few semesters. Engineers from Larson's Minnesota office mentor the aspiring structural engineers who are given the responsibility of engineering an already completed project. The students need to provide final plans/specifications and design recommendations. At the end of the term they prepare a final report and present the project to their peers.

More Than A Drafter

Tammie Domek

In addition to being a member of Larson's Appleton, Wisconsin office, Steve Gunther is a member of the Clayton-Winchester Fire Department. He has been on the department for 16 years and served as an officer for 10. In his words, "I've saved one kid, one cat and four basements." Be sure to strike up a conversation with Steve, he truly has some excellent fire fighting stories to tell.

Future City Competition

Melissa Jamison

Last fall, Melissa Jamison volunteered as a mentor for the Future City Competition (FCC), which is part of National Engineers Week. Mentors guide the students to better understand the practical applications of math and science as they work to create a future city computer model. Melissa was able to spend a day teaching middle school students the basic concepts of city development and history to help guide them in creating their own cities.

STEM

Kirk Smith

To be competitive in the global economy, the STEM (Science Technology Engineering and Math) program was developed by the Minnesota Department of Education and state government to encourage students to pursue careers in the science and high technology fields. The Minnesota Department of Education released data in early 2006 stating that only 11 percent of eighth graders and 21 percent of tenth graders expressed interest in STEM field careers and education.

Kirk Smith has been involved in the STEM program with Century College, a community college located in White Bear Lake, Minnesota. Larson Engineering recently hosted several students enrolled in an introduction to engineering class. The students came to our Minnesota office, toured the facilities and spoke with engineers and staff from each department. Kirk is currently working with Century College to further encourage students to pursue STEM oriented careers.

MS Walk

Mark Brice

This spring a team of Larson employees from the Minnesota office along with their friends and family will be participating in the 2007 Christopher & Banks MS Walk. Pledges will be raised for the National Multiple Sclerosis Society, which provides research funding, education, programs and services for people diagnosed with MS and their families and friends. The event will take place on May 6th and consists of a nine mile walk starting at the State Capitol in St. Paul and ending in Minnehaha Park in Minneapolis. The thousands of steps each participant will take and the resulting sore feet are sure to pale in comparison to the amount of good that will be done with each dollar raised.

The Benefits of Hockey

Rhonda Choudoir

Rhonda Choudoir, Business Manager for Larson Engineering's Wisconsin offices, is a member of the Fox Cities Ice Cats women's hockey team. Each Spring, the Ice Cats host a women's hockey tournament to raise funds which are then donated towards the Stick It To Cancer Hockey Tournament in Blaine, Minnesota. The tournament is a benefit event to support the fight against breast cancer. Each team volunteers a combined total of three hours to tournament operations, resulting in an even larger donation to cancer research. In 2006, the University of Minnesota Cancer Center was the designated donation recipient, receiving 80% of the proceeds for this event. This year's tournament is scheduled for April 20-22, 2007 at the National Sports Center in Blaine, Minnesota.

In addition to raising funds for Breast Cancer research, Rhonda volunteers at the Appleton Family Ice Center as a Coach for the Learn to Skate program which assists children, as young as three years old in developing their skating and hockey skills.

Rhonda Choudoir and two burgeoning hockey players
(Photo courtesy Rhonda Choudoir)

Minneapolis Central Library

where glass meets green

Kevin Schultz, PE

Located between Hennepin Avenue and Nicollet Mall in downtown Minneapolis, the new Minneapolis Central Library is an eye-catching triumph in modern building design. Overseen by renowned architect Cesar Pelli and Architectural Alliance, this LEED green building pushes the envelope of glass and specialty structure design.

Novum Structures, LLC enlisted the help of Larson Engineering in the design of the glass wall and pedestrian bridges. By working together, Larson and Novum were able to generate creative solutions that were true to the scope of the project.

The Nicollet glass wall. »

Rods every which way

Both the Hennepin and Nicollet sides of the Minneapolis Central Library have large glass walls, the largest being 103 feet tall by 57 feet wide. Lateral forces acting on these walls are resisted by rods acting in tension only. Due to the use of only rods behind the glass, a clear and unobstructed view for the entire width and height of the wall can be provided.

With tension rod resisted walls, lateral deflection is a concern. During the analysis phase both Larson and Novum found that the total lateral deflection was no more than 3.27 inches and the tension imposed on the rods would be no larger than 89,700 lbs under the design wind pressure. With the rods used and the size of the wall these values exceeded design constraints.

The entire wall is composed of multiple plates of 1 ¾" thick "Low-E" insulated glass, the largest being approximately 8 feet tall by 16 feet wide. With two five-story glass walls, and cold Minnesota winters, one could see the challenges of energy concerns. To help offset any heat loss from the insulated glass, a radiant heating system is used. Hot water flows through some of the structural stainless steel tubes, which serve as

Closer view of the glass lites. »

the back-up structure to the glass walls, supplied by Novum. This in itself brought up interesting design concerns. Would the size of the required welds on the stainless steel tubes create any problems with water leaking? How would the hydrostatic pressure within the tubes interact with the bending stresses in the tubes? Larson helped these concerns become incorporated into the design while showing that safety requirements could still be met.

Close-up view of the typical tension rod connection for the glass walls.

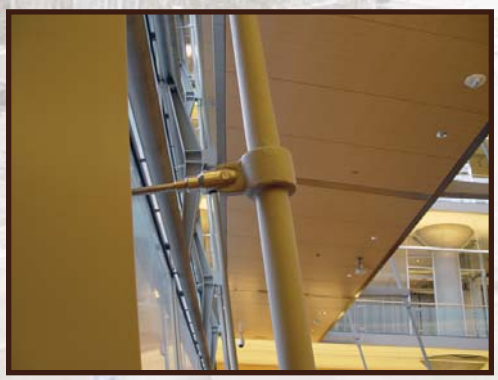
Bridge with a view

The Nicollet side of the Minneapolis Central Library has three pedestrian bridges. Spanning 48 feet, these bridges are quite close to the Nicollet glass wall and provide stunning views of both Minneapolis and the Central Library's atrium.

Constructed from built-up tapered tubes and HSS sections these bridges, like the glass wall nearby, also had rods assisting in the structural system. Similar to cable-stay bridges, the rods greatly reduce the dead and live load deflections thereby making the bridge pleasant to walk on.

One design concern for the bridges was their attachment to the concrete walls of the main structure. It was deemed necessary to use threaded steel bars with a single nut on each end as an embed for this connection. However, looking into the 2003 Minnesota Building code it was discovered that a "standard" embedment calculation for the anchor rods would be out of the question. Larson then proposed that the design provisions of ACI 318-02 Appendix D be used. Due to final submittal time limitations, Larson performed calculations using the provisions of Appendix D to supplement Novum's embed design.

The pedestrian bridges yield functionality with a minimalist architectural style, while the Hennepin and Nicollet glass walls create a dramatic entrance view. Both are indispensable parts of the Minneapolis Central Library and their contribution to this truly wonderful building inspires the next generation to push the envelope even further.



Top The completed second floor pedestrian bridge.

Bottom A typical inter-connection between the glass wall and pedestrian bridges.

Fastener ID and Design

Melissa Jamison and Kirk Smith

A common "hiccup" that occurs with projects is that of fastener identification and design. For Larson Engineering to provide you with an accurate and complete design of a curtain wall system and its connections, we present the following as an insight on our design methods and philosophy.

Grade 5 bolt head identification

Fastener Identification

All structural fasteners on shop drawings should be completely identified. The information should include the manufacturer, product name, size and material grade such as Grade 2 or Grade 5 for carbon steel and 300 Series Condition A or 300 Series Condition CW for Stainless Steel Fasteners.

Surrounding Materials

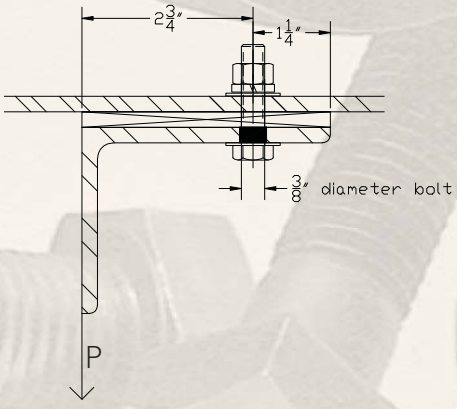
Shop drawings should indicate the surrounding building material into which the fastener grips. This information is key to the tensile capacity design of the fastener.

Connection Geometry

This is primarily related to placement of fasteners in a given connection. Fasteners in aluminum and steel connections should typically be spaced no less than two diameters apart or from any free edge. Fasteners into concrete need to take particular note of the required minimum spacing and edge distances per the manufacturers or code required recommendations.

Prying Tension

All connections with an eccentric loading require the review of an additional tensile load in addition to the directly applied tension. The two primary factors that effect the magnitude of this additional tension are the distance from the load to the fastener and the distance from the fastener to the end of the resisting element. The magnitude of this load is directly related to the ratio of the offset to the resisting element (see detail below).



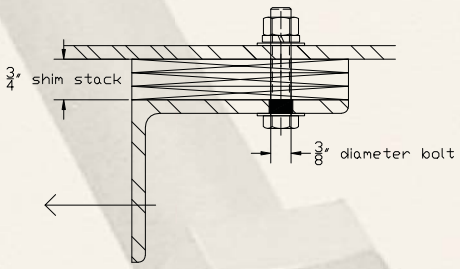
Bolt tension = P + (2.75/1.25) P

Fastener Bending

In the field, opening dimensions rarely mimic those shown on the details. Adjustments have to be made, typically via the addition of shims. Design of the load transfer across this increased dimension needs to be recognized. Bending greatly decreases the capacity of the fastener.

- Stacked Shims

Design requires the analysis of bending in the shaft of the fastener. Bending in the fastener is typically reviewed if the shim stack is greater than the diameter of the fastener.



Bending in the fastener

- Single Piece Solid Clear Hole Shims

Solid, one piece, clear hole shims are often used to eliminate bending in the fastener. However, an additional tensile load is required in this design method.

- Special Inspection

Typically this is a requirement of specific states or cities and applies to concrete fasteners. The allowable design capacity of an inspected fastener can be up to twice the capacity of one that is not inspected. Requirements vary from state to state and city to city. Check with your local code authority for specific requirements.

How Far Can That Mullion Go?

L/175? 3/4" Maximum?

Tom Renick, PE

The original source of these deflection limits is a bit hazy, but they came out of the glass industry. The 1/175 of span limit apparently evolved from a more conservative 1/225 of span limit. The 1/175 of span limit was used in the testing of glass to determine its strength. In the case of ASTM E-1300 it's used as a criterion both in the computer models that produce the design chart curves and in the testing done to verify the modeling.

The ¾ inch limit apparently came about as a limit on the deflection of members supporting the edges of insulating glass (IG) units to prevent failure of the edge seals. Further justifications for the ¾ inch limit included the discomfort of building occupants having to see large deflections of the framing members.

Architectural specifications and other standards simplified these limits to the minimum of 1/175 of the span of the framing member or ¾ inch maximum. While this limit was perfectly accurate for a single span member supporting a single light of glass, it sometimes resulted in overly conservative limits for longer span members supporting multiple lights of glass such as curtain wall mullions.

In 1996, the American Architectural Manufacturers Association (AAMA) published a Technical Information Report (TIR) titled "Maximum Allowable Deflection of Framing Systems For Building Cladding Components At Design Wind Loads" and more commonly referred to as "TIR A-11." This document suggests design deflection limits for a span "L" of L/175 for spans up to 13 feet 6 inches and L/240 + ¼ inch for longer spans up to about 40 feet.

It should also be noted that the limits suggested in TIR A-11 may need to be further restricted for such reasons as preventing the tearing of sealant, the supported cladding including brittle materials such as stone or brick, or to prevent disengagement of framing and trim. They are also applicable only to the deflection perpendicular to the plane of the glass caused by wind and similar loads. Other load cases such as blast loading may allow for larger deflections, and others such as dead load could require more restrictive limits.

Factoids

- *Americans on the average eat 18 acres of pizza every day.*
- *It was the accepted practice in Babylon, 4,000 years ago, that for a month after the wedding, the bride's father would supply his son-in-law with all the mead he could drink. Mead is a honey beer, and because their calendar was lunar based, this period was called the "honey month" or what we know today as the "honeymoon."*
- *Air is denser in cold weather. A wind of the same speed can exert 25 percent more force during the winter as compared to the summer.*
- *Sound travels 15 times faster through steel than through air.*
- *If the world were tilted one degree more either way, the planet would be uninhabitable because the equator would be too hot and the poles would be too cold.*
- *Filtering out useless information can help people increase their capacity to remember what is really important, per a recent study by the University of Oregon.*
- *Bees visit over 2,000 flowers and fly over 55,000 miles to produce just 1lb of honey.*
- *A house fly hums in the middle octave key of F.*

7	5							
		8					6	
	9		2		1		5	7
				7		3		8
	4		5	3	9		1	
1		3		6				
6	3		9		7		8	
	2					5		
							3	1

Closing Thoughts

Thank you for reading our newsletter. This publication is a cooperative effort of the offices of Larson Engineering, Inc. and, the projects we highlight in the newsletter could not be created without the cooperative efforts of our clients.

Please think of Larson Engineering as your collaborator on the creation of your next design masterpiece.

Thank you again for your continued patronage.

Ethan Charpentier, PE

Try your hand at some sudoku and hexudoku puzzles!

The objective of the game is to fill all the blank squares in a game with the correct numbers. There are three very simple constraints to follow. In a 9 by 9 square Sudoku game:

- Every row of 9 numbers must include all digits 1 through 9 in any order
- Every column of 9 numbers must include all digits 1 through 9 in any order
- Every 3 by 3 subsection of the 9 by 9 square must include all digits 1 through 9

Hexudoku games use a grid of 16 by 16 squares. Our version uses the symbols L, A, R, S, Ø and N, rather than just numbers 1-9, but the principles are the same whatever the size of the game. Enter the numbers in such a way that all symbols (that's 0-9 and L, A, R, S, Ø, N) occur once in every row, once in every column, and in every one of the 4 by 4 squares.

	7	6		0	A	3	4	Ø		5		N		S	9
						S	8	4				1	Ø		6
				1	2	9						4	7		
4			N	5	Ø				7					8	0
			0	3		8			S		6	2			
		4	R				L				1			6	S
		2		6		7	Ø	3				0	1	4	A
6		1	A	S						Ø	7		8	5	
1				4	8	N			9	6	S				
			4		9	1		5	Ø	7	2		3	N	
9		S						R			0	A			
	5	N	7						1		4	S			Ø
			L		S		6		5	2	Ø	9	0	R	
			8	N	4		1	0							7
R		0	9	Ø	5										8
	1	5	6	2				8	R		L	Ø			