Chapter 15 of Highway Capacity Manual (HCM) 2000 provides a methodology for analyzing urban (and suburban) street performance. Travel speed is the basic service measure: determination of LOS is based on average through-vehicle travel speed for a segment, or for the entire street under consideration. Average travel speed is computed from the running times on the street segments and the control delay of through movements at the signalized intersections. Control delay is the portion of the total delay for a vehicle approaching and entering a signalized intersection that is attributable to traffic signal operation. It includes the delay of initial deceleration, move-up time in queue, stops, and re-acceleration. This delay is computed for each intersection separately. Effects of coordination are being considered only indirectly through a rudimentary defined “progression adjustment factor.”

In this article we use a simple micro-simulation model to study traffic flow behavior on a signal-controlled arterial street. A fundamental 3-D relationship between flow, density and offsets, which is commonly used to describe traffic on uninterrupted facilities, is being established here for urban streets as well. The model is used to analyze arterial throughput and travel times for various densities, coordination schemes and signal spacings. It is shown that arterial throughput is dependent on the offsetting scheme while arterial capacity, as defined by the HCM, is not. Arterial capacity is limited by the constituent individual intersection capacities as determined by the saturation flow and the green split and is only realized under optimal coordination conditions for a limited range of densities.

For simplicity we use an arterial loop which is divided into segments of equal length, each one controlled by a single traffic light at the front end as shown in Figure 1. Ten traffic lights are used for the analysis (only six are shown). In this study, all traffic lights are operated with the same period $C = 90$s and the same green split $\alpha = (g/C) = 0.50$. Furthermore, the traffic lights are located at equal distances from each other with the same offset $\phi$ applied to each. No effects of traffic in the opposite direction, or cross traffic is considered. Admittedly, this is a simple model, the advantage is that one can focus on important phenomena and analyze them in great clarity without being overwhelmed or distracted by secondary effects. Within this set-up, a fundamental
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WHERE ARE THEY NOW?

2000 Thomas E. Desjardins Memorial Scholarship Winner
Michael Knodler

We recently had a chance to catch up with Michael Knodler, the first recipient of the annual Thomas E. Desjardins Memorial Scholarship award in 2000. At the time he received the award, he was a first year Master’s Student at the University of Massachusetts.

In the five years since he won the award, his life has changed dramatically. He has finished his Ph.D. in the Transportation Program in the Department of Civil and Environmental Engineering at the University of Massachusetts. This past January he joined the faculty at the University of Massachusetts as an Assistant Professor. Outside of the classroom, his basic areas of research include traffic operations and safety, and he is involved with both the Human Performance Lab Driving Simulator and the MassSAFE Program. He has remained active with ITE, taking the time to instruct several classes and give presentations at ITE functions. He also serves as the ITE Student Chapter Advisor at the University of Massachusetts in Amherst.

Since winning the award, Michael and his lovely wife Beth have had two wonderful children. They reside in western Massachusetts.
Continued from “Capacity,” Page 1

diagram for a signalized arterial has been generated as shown in Figure 2. The 3D diagram shows the relationship between flow, density and offsets. This can be compared with conventional diagrams for "continuous" or uninterrupted facilities in which flows are typically represented as a function of density and speed. The arterial speed is calculated in terms of the arterial running time and the summation of control delays for the through movements at all signalized intersections:

$$\text{ARTSPD} = 3,600 \times (\text{length}) \div [(\text{runtime} / \text{km}) \times \text{(length)} + (\sum \text{control delay})]$$

To calculate the flow on the arterial we use the following relationship:

$$\text{ARTFLOW} = \text{ARTSPD} \times \text{DENSITY}$$

For a given density the arterial flow rate (or throughput) is inversely dependent on the intersection control delay. Since the latter is a function of the coordination scheme (or, offsetting) we obtain a fundamental diagram for an urban street where the commonly used speed axis is supplanted by the offset axis. We have deliberately chosen to employ here the term "throughput" rather than "volume." There is a subtle but important distinction that is meaningful in this context: Throughput is an active term describing the output from a facility which is dependent on the way it is being operated or controlled. On the other hand, volume is a passive term commonly used to describe the demand for travel on the facility irrespective of the way it is operated. Thus, capacity flow on the facility is attained only when the maximum value of throughput can be realized. The different regions in the diagram can be analyzed in a similar way to those on uninterrupted facilities:

Uncongested Regime — When density is low and there is no congestion maximum traffic flow is attained when the offset time is set to the expected travel time on each signalized link. At this setting delay is minimized, speed is maximized and, for a given density, flow is also maximized. Since offsets are periodic with the cycle time, the maximal flow rate is periodic with the offsets. Figure 3 portrays a 2D projection of the 3D data in Figure 2, depicting the familiar flow vs. density coordinates. Shown in cross-dots are the variations in flow caused by different offsets at specific density values. The curve for random offsets (x's) is shown to be at an intermediate level between "good" and "poor" progressions. Since the flows is the product of speed and density, for any specific density it is proportional to the speed which, in turn, depends on the offsets. Improved progressions increases speed and, with it, throughput. This is the essential role of coordination on arterial streets.

Saturation: at the Brink — When density increases to an intermediate value, traffic flow is observed to saturate to a constant maximum value, which (in this case) is equal to a fixed fraction $\alpha = 0.50$ of the maximum flow if there were no traffic lights. This can be seen in Figure 3 where the x-curve with random offsets has about one-half the height of the star-curve with no signals. In the intermediate density region, while traffic flow is at a maximum, vehicles are caught in stop-and-go cycles due to un-dissolved queues from downstream signals. Offset variations have little effect on throughput in these circumstances and the cross-dot spread is reduced to a silver.

Congested Flow — In the high-density region, when traffic jams become dominant, the downstream green has to start ahead of the upstream green in order to clear the accumulated traffic on each link. The optimal offsets are then negative and we get the well-known phenomena of "reverse progressions."

Considering the data in Figures 2 and 3, the question arises, naturally, do offsets affect capacity? Strictly speaking, and using the definition of the HCM which says that "the capacity of a facility is defined as the maximum hourly rate at which persons or vehicles can reasonably be expected to traverse a point or uniform section of a lane or roadway during a given time period under prevailing roadway, traffic, and control conditions," then offsets have virtually no effect on capacity. Figure 3 shows that the capacity of the facility that is analyzed herein is one-half the value of the capacity that would be obtained on this facility if it had no signals and the flow would be uninterrupted.

Capacity (maximum) flows can be attained within a range of densities; however, there is only one density, call it $\rho_m$, at which capacity is independent of offsets. In the case studied herein this density is $\rho_m = 0.39$. At this point, varying the offsets has no effect on flow. In contrast, at both the lower density region and the upper density region offsets have considerable effect on flows and, thus, on throughput. Therefore, we can say that offsets have a significant impact on the throughput of a signalized arterial but not on its (inherent) capacity. At some densities in the very low and very high ranges

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Capacity flow cannot be attained. In the first case, because there is not enough demand; in the second, because the demand cannot move with sufficient speed.

An obvious conclusion is that one should always strive to obtain an optimal coordination. This does not only reduce delay and increase speed (i.e., reduce travel time) but, more importantly, helps to increase throughput. We know all too well that in practice this is not always possible. Here are some of the reasons: (1.) Arterial progresses must be compromised on two-way streets since the offsets are common to both directions; schemes in which one direction is favored during certain times are often used. (2.) Offset determination is constrained in grid networks due to the notorious “loop constraints.” Priority routes may be created on which preferential offsets are established. (3.) Traffic-adaptive schemes may sacrifice arterial coordination benefits in favor of local responsiveness. The trade-offs must be carefully evaluated in this case: local advantages may compromise global throughput. This study attempts to develop a more direct analysis of the effects of coordination on throughput and LOS calculations.

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**Feature Projects &**

In the March edition of the Chronicle, we introduced the Feature Projects section hoping to put a spotlight on interesting projects that you, the Chronicle readers, have been involved with. Despite the fact that there have been no submissions for the May issue at this time, we are not ready to give up on this section just yet!

We have decided to hold over the theme of “Pedestrian Enhancements” until the September issue and we again encourage all of our readers to send pictures and/or drawings with a brief description of their project for inclusion in future issues of the Chronicle. Some of the possible types of pedestrian enhancement projects that you might include are pedestrian bridges, high visibility crosswalk locations, streetscape projects with pedestrian accommodations, or any other project that focuses on pedestrian access and safety.

The Chronicle staff would really like to hear from you and we believe that your fellow readers would too, so please take a few minutes to think about what projects your company has been involved with and send over anything that you’d like to share with your fellow readers.

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**Flowers**
Elect

Alfred A. Guebert

for

INTERNATIONAL VICE PRESIDENT of ITE

Alf is currently the Senior Transportation Manager and Principal Engineer – ITS, with Earth Tech (Canada) Inc. in Calgary, AB.

He received a Bachelor of Science in Electrical Engineering, and Masters of Science in Civil Engineering (Transportation), from the University of Saskatchewan, Saskatoon.

Alf is a registered professional engineer in three provinces (Saskatchewan, Alberta and British Columbia) and is a certified Professional Traffic Operations Engineer. He has been an active member of ITE for 21 years, and has served at the Section, District and International levels. Alf has both public and private sector experience to draw upon. With more than 21 years with the City of Saskatoon, Alf assumed various leadership roles including Traffic Operations Engineer and Manager of the City's Electric System. Alf also has more than five years of experience in the consulting business as a Principal Engineer responsible for ITS projects, and is now managing the Transportation Group in Southern Alberta.

Alf has been very active in ITE throughout his career. He joined ITE as an ‘Associate’ Member in 1984, and has pursued an active role since that time. He became a ‘Member’ in 1990 and achieved the recognition as a ‘Fellow’ of the Institute in 2001.

ITE Elected Offices:
Alf served the Saskatchewan Section as the founding President (1989-1993). He then was convinced to accept the nomination to run for the Canadian District office of Secretary-Treasurer in 1993, and went on to complete consecutive terms as Vice President (1995), President (1997) and Past President (1999). Alf recently completed a three-year term on the International Board of Directors (2001-2003), representing District 7 (Canada). He is now striving to complete the cycle and become the 3rd International Vice President from Canada in 75 years... with your help!

ITE Committees:
Alf has served ITE at all levels of the Institute. At the International Level, Alf has been active in the following committees: Annual Meeting Committee (2002-2003); Strategic Plan Membership Committee (2003); International Budget Committee (2001-2003); International Nominations Committee (2002); Special Committee on Public Information Development (2001). At the District Level, during his term on the District 7 Executive Committee, he was involved in the following activities: Local Arrangements Committee (LAC), District 7 Annual Conference – Winnipeg (2003); LAC, District 7 Annual Conference – Calgary (2001); LAC, District 7 Annual Conference – Regina (1995); District 7 Nominations Committee (2000 and 2001). At the local CITE Section Level, Alf has been active as the: Founding Officer, Ad-hoc Committee Saskatchewan Section formation (1989); Founding Member, CITE Toastmasters group, Southern Alberta (2003-present); and Chair, Southern Alberta Section Nominations Committee (2004). Alf has also been active in a number of the Technical Councils of ITE: Member, Traffic Engineering Council; and Member, Intelligent Transportation Systems Council (contributing to the executive committee and providing Canadian articles for the newsletter).

Alf has also been very active in a number of other organizations as well, further developing his technical and leadership skills: Transportation Association of Canada (TAC) – Vice Chair of the Traffic Operation and Management Standing (TOMS) Committee; Intelligent Transportation Systems Society of Canada (ITS Canada) – Board of Directors and appointed to the Executive Committee; Centre for Transportation Planning and Engineering (C-TEP) – Board of Directors; American Public Works Association (APWA) – Technology exchange program to Japan. Other volunteer activities include: coaching minor Football and Hockey teams; active in church organizations, chairing various boards and councils within the local congregation, as well as participation at the national level. Alf also tries to find time to balance his professional life with hobbies such as: golf, hockey, softball, swimming, running, coaching, reading and family activities.

In 1978, Alf married Nancy, and they will be celebrating their 27th anniversary in 2005. They have two grown children: Brian (1981) who is attending the University of Saskatchewan; and Jenilee (1984) who is attending the University of Calgary. Alf’s family, as well as his employer, Earth Tech Canada Inc, are completely supportive of his desire to run for International Vice President of ITE.

When the ballots come out in June, please help to ELECT ALF by making sure your vote is counted!
EARL E. NEWMAN,  
P.E., PTOE (F)  
Assistant Director of Public Works / City Traffic Engineer  
City of Springfield, MO, USA  

I have over 35 years of experience as a Traffic and Transportation Engineer and have been a member of ITE for 33 years. With deep respect for what ITE has achieved in its first 75 years, I would like to continue my service to ITE and the profession as an elected officer. Having held elective office in ITE for 14 years and served on over 15 ITE level committees, I have the qualifications and experience for the challenge of elected office. You can view additional information about my community activities and personal life at www.bringingise2you.com.

VISION AND GOALS
I have chosen a theme for my vision to be "Bringing ITE to You." The only reason ITE exists is to serve its members. Services must reach ITE members where they are if they are to realize the full value of membership. If elected to serve as an officer of ITE, I am committed to "Bringing ITE to You."

**Member Services**
Local Sections and Chapters are the “backbone and strength” of ITE. Specially Councils are the “heart and spirit of the organization.”
1. I support the forming of local chapters to better serve the membership. The goal is to bring ITE services to the local level where members have opportunity to attend meetings and be involved.
2. I support including a specialty council membership in membership dues to increase awareness of council activities and the pool of volunteers.

**Workforce Development**
Workforce Development is twofold: It involves attracting students to the profession and continuing education for those in the profession.
1. I support programs that encourage local chapters and sections to take the lead in introducing the profession to students at an early age.
2. I propose expanded use of Interactive Web-based cost effective training to bring training to members at their workplace.

**Leadership Development**
Our leaders evolve from experience as elected leaders at various levels of ITE and/or service within a specialty council under the coordinating council.
1. I support provision of workshops in ITE governance and operations for current and potential leaders in conjunction with ITE Meetings.
2. I believe “rising stars” should be identified and encouraged to develop through governance opportunities and participation in Specialty Councils.

**Interaction with International Members**
ITE’s advantage internationally is provision of technical products, information and training.
1. I support incentives for international members to participate in Annual Meetings and in Specialty Councils.
2. I support creation of an International Advisory Committee to improve outreach and communications with members around the world.

**ITE EXPERIENCE**

**Elected Offices Held:**
I have served as an ITE International Director; Secretary and Section Representative for District 4; all Offices with MOVITE Section (President in 1994); and Vice-President, Penn State University Student Chapter.

**Committees and Activities:**

*International Level*
- Policy and Legislative Committee, Vice-Chair (2004-2005)
- Budget Committee (2003)
- Strategic Plan Membership Committee (2003)
- Transportation Achievement Awards, Chair (2002 and 2003)
- Mid-Year Meeting Review Committee (2002)
- Annual Meeting Site Selection Committee (2001)
ITE Technical Council

- Dept 4, Transportation Operations – Head (1987)
- Dept 4, Transportation Operations – Assistant Head (1984-1986)
- Dept 4, Measures Division Transportation Operations – Chair (1981-1983)
- Dept 4, Standing Committee – Member (1981-1987)

District Level/Section/Chapter Level

- Elective Officer Transition Committee – District (2004)
- Board, Student Scholarship Fund – Founding Member (1983)

Specialty Council Memberships

- Expert Witness Council
- Intelligent Transportation Systems Council
- Public Agency Council
- Traffic Engineering Council

EDUCATION AND PROFESSIONAL REGISTRATION

- Bachelor of Science, Civil Engineering, University of Missouri
- Master of Engineering, Bureau of Highway Traffic, Penn State University
- Certified in Accident Reconstruction, Central Missouri State University
- Certified Professional Traffic Operations Engineer™
- Registered Professional Engineer in Missouri and Arkansas

AWARDS AND RECOGNITION

- Distinguished Member – NOLTE (2003)
- Transportation Engineer of the Year Award – NOLTE (1995)
- Best Section and District Technical Activities Committee Report (1982)
- President’s Award for Best Technical Paper – NOLTE (1981)

PROFESSIONAL EXPERIENCE

I have 24 years of service as City Traffic Engineer for Springfield, Missouri, and as Assistant Director of Public Works the past six. I have experience in planning, design, construction, operations, maintenance and management of transportation systems. I have 11 years of private sector experience in Transportation Planning and Engineering. Highlights of my career include development of a model School Walking Route Program, preparation of the Master Plan for the Springfield, MO, Computerized Traffic Signal System and the Transportation Master Plan for roadways in Branson, MO. I am responsible for Joint Springfield/MoDOT Transportation Management Center (TMC), the first working TMC in the State of Missouri.

CONNECTICUT CHAPTER

The Connecticut Chapter held their annual joint meeting with the New England Section on Tuesday, March 29th in East Hartford, Connecticut with over seventy in attendance. The two technical sessions conducted were Highway Tolls and Value Engineering. A diverse panel of transportation experts representing the Connecticut Department of Transportation, the Massachusetts Turnpike Authority, the users, and designers was assembled to discuss tolls. The discussion was focused on the practicality to reestablish highway tolls in Connecticut, and the latest toll technologies. The Value Engineering technical session identified the process for finding innovative and cost-effective solutions for construction projects and improved transportation systems.

Awards were presented to Ms. Jennifer Carrier, P.E., for her term as President of the Connecticut Chapter; Ms. Julie Annino, Ph.D. for her Service to the Connecticut Chapter; Mr. Thomas Maziarz for Transportation Achievement; and Ms. Moria Lyons for Transportation Leadership. Mr. Arthur Gruhn was presented with an award by the New England Section for Transportation Leadership.

The keynote speaker was the former Connecticut Speaker of the House of Representatives, Moira Lyons. Ms. Lyons discussed Multi-Modal Transportation in Conjunction with Legislation, and offered her views of the need for increased gas tax revenue to support transportation improvement projects.

The results of the elections for Connecticut Chapter officers were announced as follows:
- President – Carla Tillery
- Vice President – Roger A. Krahn, P.E.
- Secretary/Treasurer – Mark G. Vertucci, P.E.

Send your Chapter information and announcements for the next edition of the CHRONICLE TO:
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Desjardins Golf Tournament
May 24, 2005, Wayland, MA

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