Implementing Engineering Judgment with an Advanced Traffic Signal Controller

By Don Maas, Senior Project Engineer, Peek Traffic

In this article we’re going to discuss the relationship between engineering judgment and traffic signal controllers. There may not be an obvious connection, but let’s start by talking about engineering judgment. Engineering judgment is one of those things that are hard to define, but you know it when you see it. Malcolm Gladwell in his book “Blink” discusses the power of the subconscious mind and notes that the subconscious can make a decision much quicker than the conscious mind, making better use of our experience. We tend to think of this as a gut reaction or a hunch. Perhaps engineering judgment is related to this too. It could be argued that as engineering judgment is growing less important these days because of the advanced technology tools we can use to support our designs. However, it is our belief that engineering judgment is even more important because of the availability of these advanced tools.

Computer aided design and drafting tools can enable us to very quickly come up with the candidate solution but engineering judgment and experience is still required to ensure that the solution is appropriate to the context and being operated effectively. In today’s world there are many advanced technology tools that can be used to support the application of engineering judgment. Software applications such as computer-aided drafting allow us to examine multiple design options and apply engineering judgment to get it just right. Spreadsheet tools like Excel let us “run the numbers”, trying out many more possible permutations and combinations than could ever have been achieved with a calculator (or a slide rule if you’re old enough to remember). Traffic simulation models enable us to predict the effects of our strategies before implementation. There is a range of tools available to us, not just to support the implementation of our judgment, but in some ways to actually enhance the development of our judgment.

Another way to look at the use of advanced technology tools for engineering judgment is that these tools can actually help us to develop a higher level of engineering judgment very quickly. The ability to “run the numbers” is a powerful tool that was not available to our predecessors who had to apply engineering judgment in order to select a limited number of options to analyze because of the resources required to analyze those options. Today we can crunch the numbers through a very wide range of options and then look at those options and detect trends and patterns. We can do “what-ifs” on a scale that the early engineers would have envied.

Most seasoned traffic signal engineers know that good signal timings are a combination of a scientific approach, technology and judgment. We have some great tools available to calculate traffic signal timings and controllers can implement these timings. There is no question that the traffic signal engineering is a science and yet each intersection requires the application of good engineering judgment. However, the tools are getting better. In the past, traffic signal engineers may have had to develop workarounds for the limitations of hardware and software but things are changing. Consider the new ATC traffic controllers. There is more than one product on the market conforming to this new standard for traffic signal control. The very best implementations of this new standard offer incredible flexibility in terms of phasing, transit signal priority and scripting. Let’s talk about phasing. The very best ATC controllers allow you to use both NEMA and interval-based phasing at a single intersection. The phasing can be varied by time of day by switching between two separate traffic engines one NEMA, one interval-based. This is helpful if there is a particular plan needed for an intersection that cannot be accomplished with the traffic engine used during normal operations. Just like two heads, two traffic engines are better than one.

Moving on to signal priority for transit vehicles, the dilemma has always been how to balance the desire to give transit an advantage against the disruption that such an advantage will cause to a finely tuned traffic signal system. The secret lies in having a traffic controller that is capable of finding the least disruptive path to normal operations after a transit priority event. There is no substitute for human judgment but more powerful and more flexible processing provides the best ATC controllers with superb abilities in this department. As we mentioned earlier, there are several ATC controllers on the market. Before you acquire an ATC controller, make sure that you’re buying the one with the best transit signal priority approach which will give you a transit friendly capability that minimizes the disruption to overall traffic flow. The speed at which a traffic signal control plan recovers from a transit signal priority event is governed by the flexibility to adapt the timings after the event. For example, when the controller can adjust to the event by seeking the optimal service pattern right after traffic signal priority is given, disruption is minimized. It could be justifiably claimed that a good ATC controller is one of the most transit friendly aspects of intelligent transportation systems.

The feature of a great ATC controller that provides the greatest flexibility however, is the ability to program the traffic engine to do new things. The best implementations of ATC controllers have a powerful scripting language available that enables new timing features to be added without upgrading hardware or software. The more powerful the scripting language, the more ability the end-user has to make it do things that wasn’t preprogrammed to do. You can do this without requiring the assistance of a software or firmware engineer. This puts the power into the hands of the transportation professional.

What does all this mean to the traffic signal engineer? It means that the science is better and that support for your engineering judgment is also better. Faster more powerful processors with flexible programming capabilities move us closer to being able to apply complete engineering judgment at every intersection in the country. While it is not possible (or even desirable) to have a qualified traffic signal engineer standing at every intersection, a good ATC controller allows a great traffic signal engineer more possibilities to apply engineering judgment and traffic management philosophy to intersections under his or her control. A traffic signal controller is a long-term investment. The hardware and software are superbly engineered to provide a long and useful life span. This is both an advantage and disadvantage. The advantage is obviously value for money and the major disadvantage lies in the need to ensure that the equipment you purchase has an upward growth path and a long-term sustainable future. It’s not too difficult to imagine that the future of traffic signal

Continued on page 57
control will converge with other intelligent transportation system applications. The presence of a traffic signal controller at an intersection provides processing power, a communication point and a power point. It's an obvious place to add more intelligence and cluster devices to create a high-performance intersection. I guess you could say that the challenge also involves engineering judgment in that it is very important to be discerning when acquiring hardware solutions for the long haul. When there is a concern about making a buying decision that has such long-term consequences, flexibility and capacity for future growth are very important parameters. It is interesting to consider the approach taken by system engineers when designing large-scale systems. They adopt an approach known as rapid evolutionary development when they encounter circumstances where requirements are changing and emerging technologies provide new capabilities every day. The philosophy behind the approach is quite simple. The initial study is conducted to determine the architecture or framework within which the solution is to operate. Within this big picture a piece of the overall framework is identified for early implementation. The piece of the overall picture is then implemented, lessons are learned in the course of implementation and the big picture is then revised accordingly. Then the second piece of the overall picture is implemented and so on. This leads to an interesting conclusion that a good advanced traffic signal controller could be the first logical step in a big picture for a smart city from a transportation point of view. Providing flexibility in processing power of the intersection along with the ability to handle open standards and various forms of communication, paves the way for an evolution to a truly smart city. In the smart city various transportation sensors are used to collect data to be turned into information and used to manage transportation operations more effectively. This can include smart vehicles, optimized transit operations, managing emissions for environmental sustainability and ultimately connecting transportation with other functions in the city such as healthcare, smart buildings, education and other information services. The decision to acquire advanced traffic signal controller could therefore provide double benefits. In the first instance there are obvious benefits for improved traffic flow management and transit priority management. In the second instance such a controller can provide the platform for future growth towards the smart city. Engineering judgment is alive and well. We have better support tools and more capabilities to look at a wider range of alternatives than we have ever had but at the end of the day human judgment is required to get the best effects. Even with the best of tools and solutions we still have to apply your engineering judgment to make the right choices. If we can combine that human judgment with the most powerful data and tools available we will surely make rapid progress towards the most efficient transportation systems.

Don Maas, Senior Project Engineer, Peek Traffic –

Don has worked in the traffic industry for 28 years. He has been involved in hardware and firmware design/testing, field deployments and project management. Don says, “I think this a great industry and I have had the opportunity to work with many talented and dedicated people.”