NEW SWITCH MACHINE TECHNOLOGY EMERGES

PRESENTED BY

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ABSTRACT

From the advent of rail transportation, the means to “switch” a train’s route has continuously evolved and is expected to continue. The initial generation of switch machines was designed to meet the ever growing functional and safety requirements of rail operators as traffic densities increased. A second generation of value enhancements, starting in the late 1980’s, makes increased use of electronic/electromechanical hybrid devices to better address life cycle issues such as improved adjustments, periodic maintenance, condition monitoring, etc. (i.e. beyond the core functionality of signal control).

Infrastructure costs associated with track-work construction and maintenance have steadily increased over time and have recently ushered in new requirements; initiating a third generation of product designs. Rail operators need to maximize profit and look for ways to reduce acquired and after sale operating costs. Specialized solutions to reduce the expense of installation and maintenance of ground equipment have become a primary focus of the suppliers’ R&D programs.

One such idea involves the placement of switch machine layout components, or better still, the machine itself, within the envelope of the rail tie (i.e. In-Tie). This evolutionary step in technology further integrates and enhances switch machine functionality while at the same time specifically addressing two key cost drivers beyond acquisition:
- Infrastructure Costs - a decreased space envelope in which to install switch machines such as tunnels or elevated structures and
- Maintenance Costs - the cost of ballast tamping in vicinity of an installed switch.

The intent of this paper is to

- Review the industry life cycle regarding switch machines,
- Illustrate the major benefits and associated savings of the In-Tie approach over traditional products and
- Highlight some actions that still needs to be done to insure general applicability to Freight and Commuter Rail operators.

INTRODUCTION

Evolution of switch machine technology has occurred at a very slow pace over the past 70 years. The market has always required a solution that move rail points, must survive the harsh environments and can operate using the power sources available at the time.

In the first half of the 20th Century, several individual mechanical devices for such things as point movement, locking and position indication were used in directing train movements. Most machines were hand throw with limited electrical control options. Supplied product lines were established in concert with the functional requirements of yard and mainline applications; i.e. specific and unique solutions for each of the yard and mainline environments. This established
the origin of the switch machine genealogy from which current designs can be traced.

In the 1950’s and 60’s, equipment suppliers used the design technology of that time to integrate, once separate functional pieces, into a single core machine with standard options such as dual vs. single control, DC/AC power, three vs. four wire control, etc. Horizontally integrated suppliers created in house core competencies that took advantage of newly established electrical control concepts in their designs (a step transition further away from primarily mechanical devices) and produced most, if not all, components. Suppliers owned their own foundries, metalworking, etc. Overall, applied costs were improved over previous generations of equipment. This vintage of equipment predominated in the market and served as the foundation for the majority of the equipment still provided today.

TECHNOLOGY EVOLUTION AND THE ‘S’ CURVE

A framework can be created for illustrating switch machine product evolution; consisting of charting market forces and resulting product performances over time. This industry life cycle generally has four distinct phases of varying lengths:

♦ disruption (moderate period of generating new ideas, determining feasibility),
♦ product design dominance (acceleration to market with continuously improved design),
♦ incremental innovations (reactive value changes focused as competition emerges) and
design maturity (longer period of product harvest, little change).
With product capability charted over time, the resulting curve resembles the letter ‘S’ \(^1\) (see Figure 1). The rates of technology change for switch machine and the rail market addressed are much slower than in the consumer industry but the evolutionary picture still applies.

**Period of Disruption**

The era at the beginning of the 1900’s, coincided with huge growth in the rail industry and a need to build a more complex infrastructure. This period introduced the need for new technology to solve problems not previously encountered; it disrupted the paradigm of the time. While the initial product offerings focused primarily on functionality and acquired cost, other life cycle factors such as ease of maintenance were ignored or considered impractical.

Now, a century later, full life cycle awareness is beginning to drive new solutions and it could be hypothesized that this disruption phase is currently upon us. This is explored later.

**Product Design Dominance**

As indicated above, those designs that best filled the operational needs of railroads, and established an industry benchmark, dominated the market. This period took a little longer for the “standards” to become established with new product capabilities emerging at an increasingly faster pace. By the end of the 70’s, core product offerings from major suppliers were clearly defined.
Incremental Innovations

As competitive pressures within the transportation industry grew (mid to late 1980’s), an in-depth look at dealing with a switch machine’s full life cycle became critical. From a railroad product procurement standpoint, lowest acquired cost was a primary focal point. Switch machines were treated as commodities and can be purchased in larger quantities through Long Term Purchasing Agreements (LTPAs).

From the supplier perspective, the developments to provide equal functionality at a lower sell price (response to customer standardization) proved time consuming and R&D investment less justified. When reviewing the full life cycle of a switch machine, ways to add value to the customer without getting into a price war, spurred new ideas and set the stage for innovations to the core product lines. Product upgrades targeted maintenance and material handling using the latest technologies to provide universality and ease of adjustment.

“One Machine For All Needs”

One supplier’s approach to universality was based on employing the best of previous functional designs in new product offerings, combined with other value add features so that a single machine could be used universally. These included such items as:

♦ Field configurability – ease of adaptation to location needs,
  ♦ Power and speed configurations
  ♦ 3,4 & 5 wire operation
Focus on Adjustments

With the advent of electronics and software, emphasis was placed on removing difficult or time
inefficient adjustments in the point detection system, for example. Mechanical contacts for
position sensing were replaced with electrical/electronic devices such as Linear Voltage
Differential Transformers (sensing position of the detector rod through differences in magnetic
fields) and proximity sensors used for measuring rail to switch blade position. These
technologies provide not only a replacement in kind but also a means by which to obtain and
record relevant maintenance data.

Event logs, along with software embedded in the interlocking control equipment that control
point movement, could then be used to assist in a preventative maintenance program.
Determination of potential failures could be assessed in advance of a failure event. What was
once a need to perform time based maintenance, would now be “as needed”.

- AC/DC Supply
- Elimination of periodic lubrication
- Simplified Inventory through modular options
- Easy Left Hand or Right Hand Throw Setup
- Restorable/Non-restorable latch-out,
- Manual Field Operation,

And so on.
CONFLICTING MARKET FORCES

The value-add, life cycle business case benefits that the innovations indicated above were meant to address have not been borne out through major changes in railroad customer purchasing practices. This is due to a limited view of looking at lowest cost during procurement rather than lowest cost over the life of the product; and other factors not strongly considered by suppliers. One is the cost and time for suppliers and customers to go through a practical field acceptance period. Another factor involves understandable resistance to change by construction, signaling and maintenance workforces. Value-add feature changes create “different machines” which involves more training for a maintenance workforce already overloaded. These opposing forces, combined with a large installed base of standardized products have stifled new product introductions.

Another, less easy to formulate driver, is the validation of the intended business case. While universal designs should truly benefit the entire Railroad, the signaling department that purchases the new and improved design must purchase a new machine at the current or a somewhat higher acquired cost and incur the training costs associated with the new machine: translated - higher cost for signaling.
THE IN-TIE CONCEPT

At this stage of the industry life cycle for switch machines in North America, there is an opening for a paradigm shift. The question is “how to attain the holy grail” of significantly reduced product and track maintenance and reduced infrastructure to provide a universal solution for the entire life cycle. One such approach that gets closer to this vision may be to employ the concept of an In-Tie machine.

A Machine In Place Of A Tie

A new switch machine has been developed (under ALSTOM’s SMARTWAY Signaling Product Line) for operating individual and dual switch points in freight, commuter and transit applications. Installation is achieved within the dimensions of a single railroad tie therefore eliminating associated rods. The MET switch machine offers perfect switch point stability, extremely compact size, absence of external parts, universal application, long periods of service without maintenance and simplicity of failed components swap out through modular design.

Product Overview

The MET is made up of a metal base and housing, fixed through adjustable brackets to the stock rail. It is placed in the position of the first tie, on the first slide plate, on the switch point using two bolts per point. Slide plates are made of low friction materials that do not require periodic lubrication. Switch locks are fitted to the stock rails, lock and electronically detect point
position. Electrical contacts interrupt control energy when operating in hand crank mode. The machine has been developed to work with either standard option of AC or DC signaling supplies.

Given this new approach, two key and several other drivers of installation and maintenance cost can now be more effectively addressed.

**Addressing Key Cost Drivers with A New Machine**

At present, most systems of the switch point movement are made up of an electrical switch machine placed beside the track with the throwing, detection and lock devices inside. These devices are connected to the blades through a system of external rods laid between ties.

*Attacking the Tamping Issue*

Unfortunately, typical switch machines and layouts do not allow a complete tamping of the ties and prevents the automatic tamping of the tracks. This partial tamping causes, over the passage of time, a lowering of the ballast under the switch machine. Under the weight of the trains, the tracks tend to bend and the busier the line the worse the problem becomes.

These strains can cause considerable wear and tear to the switch point and to its individual elements. For example - to the rods, the internal parts and to the sliding bearing. Under such conditions, the line therefore requires frequent manual maintenance including lubrication of the switch point, which directly increases local pollution. Location of the machine within the
envelope of the existing ties (elimination of rods and cables) therefore eliminates tamping as an issue.

Infrastructure Benefits

The MET can be used on all the switch points. Due to the absence of external parts, it is particularly advantageous:

- in yards where switch machines are highly concentrated;
- in tunnels where the passageway has no obstructions and diameter could be smaller leading to significantly reduced new construction costs,
- in viaducts or elevated structures where the construction of protruding structures is not necessary or prohibited and
- in underground locations where it is not necessary to create and maintain knock outs to make room for machine and associated rods.

Personnel Safety

Reduced maintenance time, ease of repair, and more modular designs directly lead to a large increase in personnel safety. While a conceptual argument, it is possible that having maintenance performed while standing between the rails may actually be better since there is a greater urgency to complete work due to oncoming train traffic. In concert with procedures outlined under Railway Workers Act, time spent in harms way is greatly reduced.
Other Benefits

The in tie concept affords greater switch point stability, reducing friction and wear and ballast pollution associated with over lubrication. The space savings can also provide a better foot passage within complex yard locations.

Technology Validation in Off Shore Applications

The In Tie (Sleeper) Concept originated in Europe in the 1990’s. Suppliers now have established products that serve mainline railway uses (primarily commuter traffic). The market can be typified as lighter weight trains operating at higher average vehicle speeds, small but growing freight tonnage, hydraulic/pneumatic control and AC signaling supplies. Several long term purchasing contracts have been awarded for In Tie style designs. A parallel concept has also become prevalent where rods and cables, previously laid between ties can now be laid inside of hollow ties; providing a similar benefit to ballast tamping. The primary focus for suppliers, now, is to adapt this proven technology to the very different environment of the Freight and Commuter markets in North America.

Market Acceptance of the In-Tie Approach

The promise of In Tie technology is significant and the marketplace is responding. Trials have been approved on several class 1 railroads. The intent is to replace all current generation
machines. Market acceptance will greatly influence whether this new technology replaces or merely supplements currently supplied equipment. A few factors can expedite the introduction and instigate the transition from the disruption to design dominance phase on the technology ‘S’ curve.

**Closer Supplier, Customer Relationships**

The In Tie technology truly provides the best value to the customer. The goal is for a WIN-WIN situation to emerge for both customers and suppliers of switch machine and other signaling components. This goal must come from both parties understanding all business aspects of the life cycle. Business case models to this point are not clearly quantified and are only qualitatively assessed [benefit/cost/ROI] with respect to individual customer functional organizations. The In Tie machine directly benefits the track and construction organizations and indirectly benefits the signaling organization. The costs associated with inventory handling, spare parts, training, etc must all be considered to clearly show this value proposition.

**Adaptation of RS&I, Railroad Processes**

Current Railroad, Federal Railroad Administration RS&I [2] (section 236) and AREMA (section 12.2.1.b) maintenance and test procedures involving switch machines have been in existence for decades and are directly related to the incumbent generation of supplied products. It is extremely critical to address the new technology and its relevance to existing rules and regulations. It is expected that modifications are likely.
SUMMARY

The product life cycle for switch machines is very long and strongly dictated by short-term needs of railroad customers at any given time. Those needs have evolved from a traditional product “purely signaling functional” basis to current day life cycle orientation. Current offerings from suppliers are mature and nearing the end of the technology ‘S’ curve. The promise of the In Tie approach should result in a paradigm shift and thus initiate a whole new product line that truly offers a “solution” for the customer. In order to accomplish this, however, a close working relationship between suppliers, rail customers and Federal agencies is required.

ALSTOM is currently working with customers and the FRA on bringing this new technology to market with its MET product offering.
ACKNOWLEDGEMENTS

The author would like to express his appreciation to ALSTOM Transport Information Solutions associates Kirsten Annweiler (NA Product Marketing) and Pamela Rockow (Electromechanical Product Management) for their input and support on this paper.

REFERENCES

[1] Developing and Managing a Successful Technology and Product Strategy - Massachusetts Institute of Technology Executive Seminar

Initiation of Wayside Point

Integration of point control, indication, lock, dual control, ...

Dominant Product Lines Emerge

Incremental, Value Add Upgrades

1900-1920
1940-1960
1970-1980
2000’s

Figure 1 - ‘S’ Curve For Switch Machine Technology