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Ford Motor Company
The success of Ford's Lean IR program
"*Lean-IR Maintenance is not random, careless or intermittent at Ford DSP*"

Fords Dearborn Stamping Plant (DSP) at the Rouge facility in Michigan is leading the way in integrating the concepts of Lean with their Infrared Predictive Maintenance Program

By: Fred Colbert of The Professional Thermographers Association

And with tremendous input and support from the LeanIR team at Ford DSP, Jim Jackson, Rick Cox, Hassan Koussan, Chuck Larabell, and John Lafeber

Abstract:

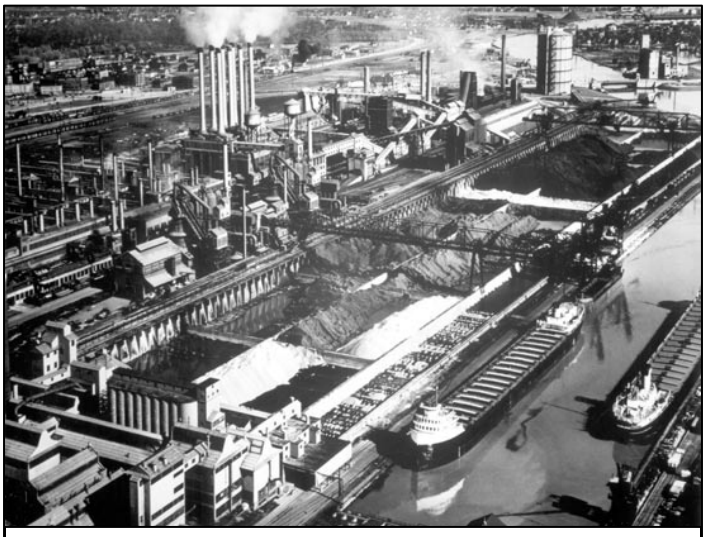
Lean Principals, first introduced by Taichi Ohno of Toyota Motor Company, have been influencing large and small business' world wide by providing a blue print on ways to reduce waste while increasing productivity. Today's leading companies like Ford, Dell, Southwest Airlines, and FedEx are reworking their business models based on adopting Lean principles and are reaping tremendous benefits that continue to insure their success in their respective markets. It is a natural migration of these Lean principals from Lean Manufacturing, to Lean Maintenance, to Lean Predictive Maintenance, to Lean IR. Concepts that have provided the insurance of the rebirth of the IR program at Ford's DSP.

Fords Rouge Dearborn Stamping Plant (DSP) has been leading the way with adopting these Lean concepts to their IR Program to be able to increases their up time dramatically by the integration of Lean Thinking with their IR program.

> *"I would like the Rouge again to be the most copied and studied industrial complex in the world. My great-grandfather would have thought this was fantastic."*
> **William C. Ford Jr.**
> **Chairman & CEO, Ford Motor Company**

Rouge Quick Facts

By 1927, the Rouge was the world's largest industrial complex. Located along the banks of the Rouge River in Dearborn, Michigan, all steps in the manufacturing process took place at the vast Plant. Today, the Ford Rouge Center is composed of 600 acres. With five manufacturing plants, it is Ford's largest single industrial complex, employing about 6,000 people.



Aerial view of the Rouge, January 19, 1947. Photo: P.833.85200

The new Ford Rouge Center includes one of the world's most advanced and flexible manufacturing facilities, capable of building up to nine different models on three vehicle platforms. The plan includes numerous pilots of advanced environmental concepts designed to balance the needs of auto manufacturing with social and environmental concerns – and save money.

The Dearborn Truck Plant is the centerpiece of the new Ford Rouge Center, the largest industrial redevelopment project in U.S. history and the flagship of Ford's vision of sustainable manufacturing for the future

Overview of Lean Concepts

What is meant by Lean?

The concepts of Lean Thinking are at there very core, very simple, but it is in that simplicity that the concept is sometimes misted because of a over simplification in the way that they are understood. It is very important to note that Lean Thinking and Lean Concepts are not about increasing revenue by reducing (spending less) or cutting back on staff or personal, but that by adopting Lean concepts it will release funds because of a decrease in effort and waste, and that these resources can be utilized in more productive areas by allowing personal to be do other tasks more efficiently. When Lean Thinking or Lean Concepts are confused with trying to find ways to cut operating budgets, the principals and benefits of Lean are completely lost.

Lean Thinking is simply the discipline of: *doing more with less and less*... as in less waste and less effort! But to define what waste is, in any system you must first establish what is of value, and look at what actives either ad value to the end results or do not contribute, or diminish that value. Any thing that does not directly add value to the process is waste. The Japanese term for waste is *Muda.*

Muda

Waste (Muda) can be defined as any activity that consumes resources and does not create any value!

Defining Value and the Value Stream

Once the value adding activities and processes are defined, the next goal is to line these actives in a sequence that allows for the Flow actives and materials to complement each other in order to establish a continues momentum that will dramatically reduce the throughput time. This lining up of value adding actives and material is in direct opposition of the typical *batch-and-queue* production concepts that are so common in many industries, and for many, seems counter- productive at first. But once a solid value stream that eliminates all of the wasted steps is established is, enormous benefits are recognized. When this system for the Flow of the value stream is set in place and complemented with visual controls that allow for transparence across the system and methods for error proofing, so that gremlins don't creep into the system, are enacted, then production can run very effectively and quickly. This effectuality in the delivery system allows for downstream actives to literally pull the products through the value stream as demand needs.

Kaikaku: The initial benefits of adopting Lean Concepts

The return on the investment of implementing a Lean system has its own name, Kaikaku which means – Radical improvements, has many direct benefits to the overall system. More is being done with less effort, waste and fewer errors than before, which translates to being able to better utilize the company's resources at hand This frees up capital to be budgeted in areas where it can be better used to insure the company's longevity, and everyone wins!

Kaizen: The road to perfection in your program

The discipline of continuous, incremental improvement to the lean system is a continuous reappraisal of the value stream, looking for any way possible to continue to eliminate any waste and increase value. Kaizen helps to insure that the lean system stays on track and is always working to find ways to improve the system

Infrared at Ford DSP

The Infrared program prior to Lean IR

Prior to adoption of a lean approach to Thermography, Ford had been instructed by one of the IR camera manufactures to just take a reference Thermogram of each piece of equipment in the plant, create a report, print it out, and then attach the Infrared image to each piece of equipment in their facility. This would be used as a reference image/report that the next thermographer performing the inspection would simple use as a reference / baseline image for comparison. This practice would lead to a wall papering approach of infrared images being attached to every piece of equipment in the entire plant. This approach was not only unpractical and a enormous waste of effort, but the images in the plastic sleeves would become illegible because of the harsh working environments. Trying to manage the hundreds of thousands of images/reports proved quickly to be a complete failure.

The development of Lean IR program at Ford DSP

It was obvious that a different approach had to be adopted that would eliminate the wasted effort and better utilized the resources that Ford had. A major effort was made to map out the value stream a look at what the actual value was of their IR program, along with a committed effort of eliminating any wasted effort became the focus. The traditional batch and queue data collection / report generation methods that were supplied by the camera manufacturer, had proven to generate a tremendous amount of wasted effort and time, while not adding any measurable stainable or cumulative value to the overall IR program. It was not a specific failure of the IR equipment or the training of the Thermographers on staff, they simply did the best with the software tools and approach that they had been given. To establish a IR program that would honestly continually contribute to the Predictive maintenance objectives and not be just a flash in the pan, they had to re-approach their whole method of how they conducted the inspections and how they could retrieve data on the fly, as well as add to the body of knowledge that was being amassed.

Ford DSP sought the support of Fred Colbert to help with the evaluation of the program and in assisting in establishing a IR program based on the inspection methods that were being used by Colbert Infrared Services, Inc. for their customers world wide, that are based on a mobile database solution called Thermal Trend. One of the key components of Thermal Trend was in the way that the value stream has been mapped out by focusing on how a Professional Thermographer actually performs their inspections. By empowering the thermographer with the right information in the field at the right time (Just-in-time) and establishing methods to eliminate the wasted effort of data collection and report generation as well as error proofing in the data collection, Ford DSP would be able to achieve an IR program with a solid foundation of accountability that would also provide for a knowledge base legacy that can transition from one inspection, or thermographer to the next. These methods were established by Fred Colbert well over 25 years ago when performing Infrared inspections for the US Navy and have been incorporated into Thermal Trend.

Defining value and eliminating waste

The batch and queue approach to manufacturing cars has been radically changed from the warehousing of parts to just-in-time delivery of part for the assembly of vehicles. By understanding the entire process of manufacturing a car and looking at the how to align the flow of materials into the assembly process, auto manufacturers have been able to eliminate the waste of resources because of the elimination of wasted steps in the assembly process. This same approach was adopted to look at ways to eliminate steps prior to, during, and after the inspection.

Eliminating Waste - hard questions had to be asked!

Prior to implementing LeanIR at Ford DSP there were a number of question that needed to be answered. Unfortunately, there was no real system in place to be able to provide the answers if DSP was going to have a World Class IR program.

- How much wasted effort is there in the methods of, data collection, image analysis, report generation and program management?
- What system is in place for determining what is to be tested vs. not tested?
- How do you account for what you did, or did not test, in this inspection, last inspection, or the inspection before that?
- How do you know, when you are in front of a piece of equipment to test, if it had a past problem from previous inspections, and how do you know what the status is before you open up the panel?
- How do you know how long that problem has been there, what the time-over temperature trending data has to show, to accurately evaluate the severity of the problem?
- How many problems have there been on a specific piece of equipment, product line or in the entire plant? How many of the problems are chronic conditions vs. acute?
- How many problems have been fixed correctly and how many are still open?
- What components are failing the most frequently, and why? Reports and Trends?
- What are the errors in the data, why are they there, and how do you "error proof" the data that is being collected? Why does this happen? How can this be prevented?
- What data collection methods do you have in place to eliminate the batch and queue process of report generation, and enhance "Flow of Just-In-Time" data collection and reconciliation during the inspections.
- What systems are in place to allow for the "Pull of Just-In-Time" data for reconciliation of problems during the data collection process while the inspection is being conducted?
- What visual controls are in place that allow for an overall perspective of the status of equipment, as well as the overall program.

Flow

Focusing on Flow: Taking this same approach to the gathering of inspection data and integrating it into an Infrared thermographic program was the focus of the folks at DSP. By utilizing a mobile data collection and retrieval system in the field by the thermographer while they were actually performing the inspection would eliminate the typical batch and queue method that is so typical of infrared inspection report generation. Using Pocket PC's for data collection would eliminate the wasted effort of redundant data entry that is required of the typical Infrared reporting software. But the software on the Pocket PC must be inline with the work FLOW of the thermographer allowing them to intuitively navigate the software program on the Pocket PC without any wasted effort.

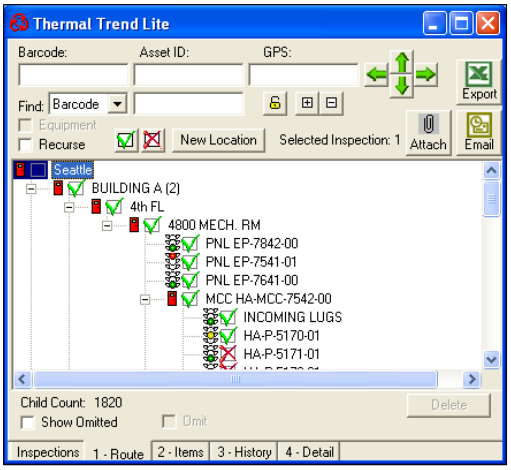
Thermal Trend

The Thermal Trend database provides Ford DSP with a solid inspection program infrastructure by utilizing a mobile database solution that provides for in the field, data collection and reconciliation during the actual inspection. This approach to thermography is in concert with the principals of Lean Thinking concepts, allowing for the ability of Fords thermographers to be able to provide more value then the previous testing and data collection methods in the past, and establishing greater throughput in less time.

Methods of Error Proofing

A major focus on achieving this goal is in finding way to eliminate mistakes in the data collection process. Having the thermographer who is directly responsible for the quality of the data collected, being able to enter the findings immediately into the database at the time of the inspection would eliminate the wasted effort of having to type the report at the end of the inspection.

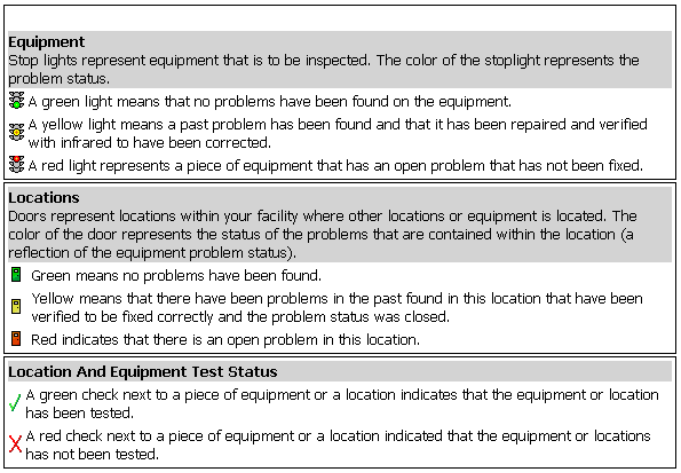
Established Routes: By establishing specific logical inspection routes that the thermographer would follow helps to insure that everything that was selected to be inspected was actually tested. The Thermal Trend database establishes a Plant Configuration based on the plant floor systems infrastructure of a plants physical configuration of assets. This allows for the logical grouping of equipment to be inspected into routes. These routes are set up in a natural hierarchy, based on equipments proximity to each other. This hierarchy is displayed in Thermal Trend's database as a Route Navigator user interface, that's very similar to Windows Explorer style user interface, as a structure of locations and equipment. As the locations are expanded or collapsed, the different levels of the route hierarchy are displayed.



The Route Navigator not only provides a familiar Explorer user interface for viewing and exploring a plant's locations and equipment, but also allows the thermographer to quickly see both the test status and problem status of any equipment in the database. These Visual Controls are displayed as in the hierarchal tree as Smart Icons that change color based on condition of the equipment.

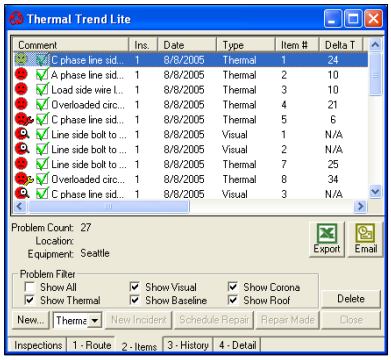
Bar Codes: Using bar codes as unique identifiers on equipment and locations greatly assisted the thermographer in quickly finding the specific equipment record in the database and PULLING up the history. By utilizing bar codes whenever possible insures that mistakes are not made by writing up the findings on the wrong piece of equipment. By searching on a bar code number when the bar code label is scanned by the Pocket PC, the equipment record is quickly located in the database route

navigation view, which greatly assist the thermographer to focus on performing their inspections as compared to having to manually having to look up the equipment.



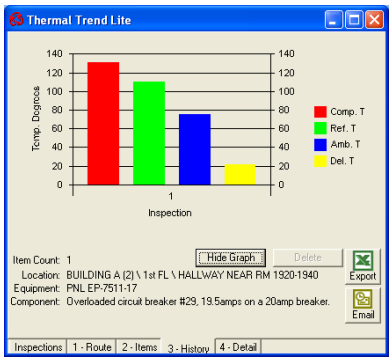
Using Visual Controls and Smart Icons

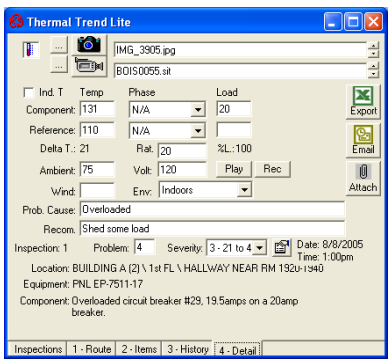
Pull on demand, just-on-time information:
By utilizing a mobile database solution that has the cumulative knowledge of all of the previous inspection, the Thermographer must be able to easily PULL the required historical data from previous inspections on a specific piece of equipment that they may have questions about. The software / database solution must integrate this Lean business logic into the user interface so that it empowers the thermographer to do their job more effectively and with less effort. In essence allowing them to do more with less and less (better inspection with less effort).

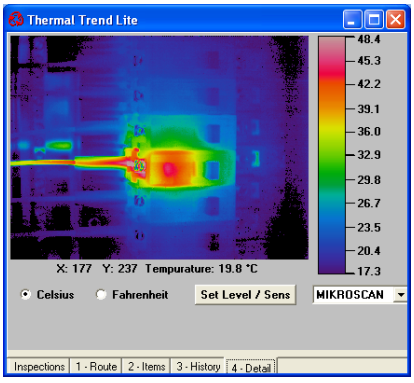


Items that are found during the inspection are entered directly into the database that is running on the Pocket PC. This eliminates the necessity of have to type up a report at a later time, and also allows for the thermographer to easily reconcile any past problems that were found from previous inspections to make sure that the repairs were done correctly.

All problems conditions are trended over time showing any changes in their status with regards to temperature changes and repair status. Thermal Trend automatically tracks the problems from cradle-to-grave on all of the equipment. The thermographer has at their disposal all of the historical data with regards to all of the problem that have ever been found at a facility. They can easily review all of the specific information with regards to any problem, and well as view the all of the previous infrared and photo images that were taken. This allows for a transfer of knowledge that is able to span multiple inspections and different thermographers. Thermal Trend provides a platform for the aggregation of historical data that can be cumulatively analyzed to see the health of any piece of equipment or of the entire facility, or for comparative analysis between facilities.







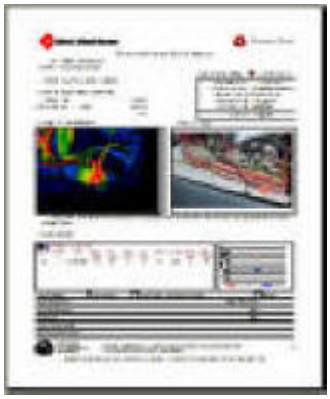
Documentation, Communications, EDMS - Electronic Documentation Management System and Reporting

Thermal Trend provides a very wide variety of reporting possibilities, from predefined report templates and email alerts to the ability to export the data or integrate the database into other existing database solutions for PdM or CMMS system.

Microsoft Outlook Integration and Drag and Drop EDMS.
Communication of inspection results plays a critical role in a IR program. Thermal Trend has built in integration with Microsoft Outlook allowing you to easily email finding directly out of the data base without having t generate a report. You can easily query and filter the specific data that you need to send. Plus Thermal Trend has Drag and Drop EDMS straight out of Outlook that allows you to take email, appointments, tasks, notes and attachments directly out of Outlook and automatically attach them directly into the database where you want them, closing the loop on follow up communications on inspection findings.

The most comprehensive reporting system for Predictive Maintenance:

- Detailed hard copy reports:
  - Thermal
  - Baseline Trending
  - Envelope/refractory
  - Visual
  - Ultrasonic
  - Ultraviolet
  - And many more.



- Executive Overview
- Prioritized Lists
- Problem Details
- Closed problem tracking
- Open problem tracking
- Benchmark and Baseline Trending
- Historical Test Status
- Cost/Benefit Analysis

Kaikaku: The radical improvement benefits of Ford's Lean IR program
The complete turn-around of the program was evident within the first week at Ford's managers meeting. The ability to have complete accountability that was easily attainable and sustainable in such a short time span was not only a reflection of Thermal Trend, but also in the dedication of all personal that believed so strongly in this Lean IR solution.

Within the first month there was an insurance audit conducted that evaluated the overall performance of the infrared predictive maintenance program at DSP. The rating that was given was the highest within all of the Ford Company! (In fact the auditor from the insurance company said that their own IR program could not match that of Ford's DSP)! The ability to have complete accountability of what was tested / when, to be able to report on problems immediately without having to spend time typing up reports, the ability to track all of the repair actions timeline, and reconcile the problems (before vs. after) without any extra effort has made a tremendous impact on DSP uptime production. There have been additional audits done by the insurance company and also ISO and each time the DSP Lean IR program has been given the highest marks within all of Ford.

Kaizen: Outlining Ford's commitment to Quality is Job #1

Continuous incremental improvements towards perfection have not stopped since the implantation of Thermal Trend. One of the concerns by the plant manager was in being able to track the progress of repairs on found problems over time. It was felt that if the United States can send a man to the moon then at Ford DSP, any problems that are found should be repaired and reinspected within two days. Since Thermal Trend not only tracks and trends the condition of the actual problem, but also tracks the cradle to grave progress of scheduling repairs and results of the repairs, is was easy to create a report for the plant manager that would show the repair status and life span of any problems that were found. This report is presented weekly at the plant managers meeting and every problem that has been found is closely monitored to track the response time and expedition of any repairs that need to be made.

In addition, Ford wanted other refinements to Thermal Trend so that it could play a more integrated role in their overall PdM program. A development contract for the customization of Thermal Trend was put in place to meet the growing needs of Ford's Lean IR program. These include, but are not limited to:

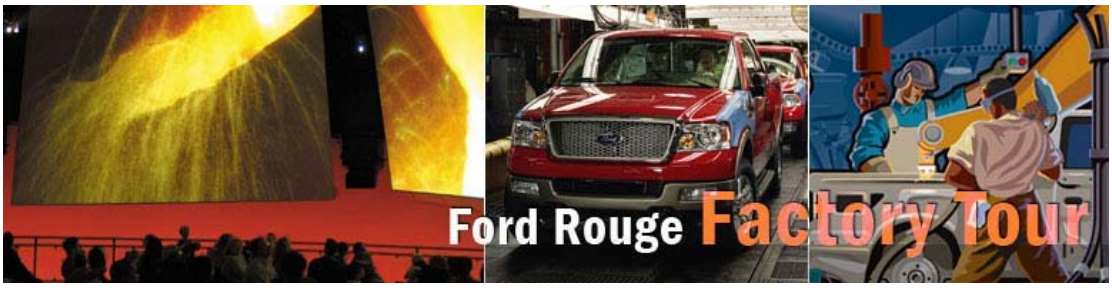
- Enhanced integration with Ford's CMMS system, MAXIMO work orders
- The addition of Ultrasound testing as a type of inspection methodology that can be conducted in conjunction with Infrared.
- The ability from within Thermal Trend, to directly open, change the scale, pallet and analyze the infrared images from the different camera manufactures ie: FLUKE-Infrared Solutions, FLIR, Mikron/NEC, Guide IR, etc. without the necessity of having to saving the IR images as BMP or JPG files using other software packages. This allows Ford for one software application that is the cross roads to read all of the different IR file formats for all of the of the IR cameras that Ford has.
- Enhanced workflow tracking and scheduling of routes.

Based on the requirements of Ford DSP and other development partners needs, Thermal Trend has introduced a complete intergraded office suite of software solutions based on the proven success of Thermal Trend. The new office suite is developed in a Microsoft .NET environment that fully provides for the cross platform development between desk/tablet/Pocket PC, and fully exploiting the web integration of that environment. The database backend is based on Microsoft SQL 2005 providing for a very robust environment that allow for enhanced capability for on the fly wireless synchronization of data over the inter/intranet.

Thermal Trend Office Suite includes:

- **Thermal Trend – Lean**
  A desktop/mobile/web PdM database solution (Microsoft .NET/SQL 2005)
- **Thermal Trend – Image Viewer**
  A IR image viewing utility program for the management of images from different IR manufactures.
- **Thermal Trend – Image Analyzer**
  A advanced image analysis and reporting program that works with IR images from different IR manufactures from within standard Microsoft Office applications like Word, Excel.

Summary:



The (Lean IR) Infrared PdM program at Ford DSP truly lives up to William Ford's dream. It is a tribute to everyone involved, and the dedication that they have to keep that dream alive. Today, the Lean IR program at Ford's Rouge DSP is one of the most studied IR programs in existence. Other Ford divisions as well as other auto manufactures, and many others are taking their lead from the Lean IR team at the Rouge.

The next time you are near Detroit MI, you should head over to Dearborn and take the Ford Rouge Factory Tour. And remember to take lots of notes, Henry Ford would be proud of you!

More Information:

The Ford Rouge Factory Tour go to: http://www.hfmgv.org/rouge/default.asp

For more information on Lean Thinking, please refer to the excellent book by James P. Womack and Daniel T. Jones.

Lean Thinking, Banish waste and create wealth in your corporation
Published by Free Press, ISBN 0-7432-4927-5

There are also a number of web sites on Lean Thinking, Lean Maintenance, and Lean IR:

www.Lean-IR.com

For information about Thermal Trend please go to:
www.ThermalTrend.com

For Information about training and support for Lean IR programs please contact:
www.ProThermographer.com

To contact Fred Colbert, FredC@Colbert-Infrared.com

Glossary of Lean (Lean IR) Terms

Below is an abridged Glossary of lean terms found in physical production, from the book, *Lean Thinking* by James Womack and Daniel Jones. Below and indented to the right of each term is how these terms are applied to the practice of implementing a Lean Infrared program.

Batch-and-queue – The mass-production practice of making large lots of a part and then sending the batch to wait in the queue before the next operation in the production process. Contrast with **single-piece flow**.

Lean IR: The practice of grouping data collection and report generation tasks into batch-and-queue process that do not allow for any Pull or Flow of actives and increases the overall throughput time. For example: The practice of grouping all of the photos and IR images in a batch to perform post inspection image analysis, or to then start to type up a report after the completion of an inspection. The batch-and-queue type of production system significantly increases the overall throughput time as compared to single-piece-flow.

Flow – The progressive achievement of tasks along the value stream so that a product proceeds from design to launch, order to delivery, and raw materials into the hands of the customer with no stoppages, scrap, or backflows.

Lean IR: The continues flow of inspection data that is accessed or input in a progressive system that complements the tasks that are being performed by the thermographer while they are conducting their inspections.

Just-in-time – A system for producing and delivering the right items at the right time in the right amounts. Just-in-time approaches **just-on-time** when upstream activities occur minutes or seconds before down stream activities, so single-piece flow is possible. The key elements of Just-in-time are **flow, pull**, standard work……..

Just-on-time – See **Just-in-time.**

Lean IR: The delivery of just the right inspection information to the thermographer when and where it is needed. This delivery system must not overwhelm the thermographer with to much information or not present enough, but must match the demands required, at just the right moment, without impeding the momentum of the Pull or Flow of the inspection.

Kaikaku – Radical improvement of an activity to eliminate muda. The radical benefits from implementation of a Lean system.

Lean IR: The radical improvements within an IR program by adopting a Lean Infrared system that's focus on the eliminating of wasted effort while adding value that is both cumulative and stainable. Allowing the IR program to do more with less effort, which insures that the investment in the implementation of an infrared program truly sees its return on the investment that has been committed to it over the long run. (In contrast

making sure that the IR program is not just a flash in the pan in its startup but cannot justify is existence in the long run)

Kaizen – Continuous, incremental improvement of an activity or create more value with less muda. The discipline of continues development effort for seeking perfection in all aspects of the system. Kaizen is not perfection; it is the process and discipline of working towards that goal. It is the discipline of the journey too, not the destination. It is the practice of re-evaluating your system and finding incremental ways to improve the system towards perfection.

Lean IR: The practice of evaluating the overall system and establishing new goals and objectives to incrementally improve the methods and best practices involved in the conduction of infrared inspections as well as the way that the results from these inspections can be distributed better within the organization. It involves the thermographers, managers, software developers, all working together to enhance the system while being dictated to the principals of lean thinking.

Lead time – The total time a customer must wait to receive a product after placing an order.

Lean IR: The total time that management must wait to receive the findings (report) of a inspection.

Muda (Waste) – Any Activity that consumes resources but creates no value.

Muda, Seven types found in physical production.

1. Over-production ahead of demand.
2. Waiting for the next processing step.
3. Unnecessary transport of materials.
4. Over-processing of parts due to poor tool and product design.
5. Inventories more then the absolute minimum.
6. Unnecessary movement by employees during the course of their work.
7. Production of defective parts.

Lean IR: Seven Types of waste

1. Not having a clear, defined route of what is to be tested.
2. Inefficient methods of inspection data collection and reconciliation in the field.
3. Redundant data entry once in the filed and then back at the computer
4. Data entry errors, Incorrectly identifying equipment that has a problem, etc.
5. Having to correct data entry errors. Having to go back into the field to get the correct information on a piece of equipment or a problem.
6. Not having a good method of establishing what IR and Photo images go with which problem.
7. Having to convert proprietary IR image files into BMP or JPG files

poka-yoka (error-proofing) – A mistake-proofing device or procedure to prevent a defect during order-taking or manufacture.

Lean IR: A device or procedure that prevents a data entry error to be made. An example would be the use of bar codes that are attached to

each piece of equipment that is to be inspected, and the use of a Pocket PC with a bar code scanner that will scan the bar code and located the exact piece of equipment in the database for the thermographer to enter the findings of their inspection for that specific piece of equipment. This insures that the correct piece of equipment is tested, that any problems that are found are entered on the correct piece of equipment and that any past problems are correctly reconciled. Error proving can also be implemented in the way that the business logic is implemented in the software to insure that mistakes are not made. For example, checking off a piece of equipment as tested when in fact it has an open problem from the past that has not been reconciled and closed. The software would not allow for the equipment to be checked off as tested until the open problem has been reconciled first. Another example is using a Pocket PC or tablet computer in the field that is running the database and placing the responsibility and custody of the data being entered correctly into the database into the thermographers hands. This eliminates any data entry errors by eliminating the problem of illegible field notes and allows the thermographer to double check their data while they are still in the field conducting the inspection.

Processing time – The time a product is actually being worked on in design or production and the time an order is actually being processed. Typically, processing time is a small fraction of **throughput time** and **lead time**.

Lean IR: The time required writing up a problem in the field, or the time required to enter a problem into a computer.

Pull – A system of cascading production and delivery instructions from downstream to upstream activities in which nothing is produced by the upstream supplier until the down stream customer signals a need. (The opposite of Push)

Lean IR: having a system in place in which data can easily flow to the thermographer when a inspection activity requires the data to be pulled from the database to assist in the inspection. For example, when a thermographer, conducting an inspection, needs to reexamine a previously documented problem from a past inspection. The thermographer will pull up the past data records to review so that he can reconcile the past problem during the inspection. Another example is when someone wants a specific type of a report to view or print, they are pulling up the data. The data is delivered when, where and in the required form that the end user is requesting, in the field on a Pocket PC or tablet, or on a computer screen, as an email, as a print-out or an export.

Queue Time – The time a product spends in a line awaiting the next design, order-processing, or fabrication step.

Lean IR: The time between gathering the inspection results, of a problem that was found in the field, and inputting it into a computer (report or database) for report generation.

Right-Sizing – The right sizing of tools or production devices that match the momentum of production so as not to impede the **flow** or **pull** of production.

Lean IR: The correct solution to the task that is designed to be complementary to the requirements of the task at hand. For example, having the correct IR camera that meets the needs of your inspection requirements. You would not want to have an IR camera that did not have the required special resolution to be able to find a problem. On the other hand, you would not want a complex research and development camera that required a elaborate and long set-up and AC power supply if you are only going to be looking at lighting panels. The same applies to the data collection and reporting solutions that your facilities needs. Hand written notes on a post-it pad vs. a database solution that is so robust that it could manage the finances of the World Bank would be an extreme over kill. Matching the camera and data collection solutions to your requirements will provide the correct solution that will complement, not impede the flow and pull of the inspection and the data.

Single-piece Flow – A situation in which products processed, one complete product at a time, through various operations in design, order-taking, and production, without interruptions, backflows, or scrap. Contrast with **batch-and-queue**.

Lean IR: Is where a problem that is found in the field is directly entered into the computer at the same time that it is found. Results are immediately reported at the time of their discovery into the database, thus eliminating the typical time delay of inspection results based on a batch-and-queue data collection system that must be entered into a computer as some later date. Each piece of data that is discovered / entered during the inspection is immediately entered directly into the database allowing for a complete up to date perspective of exactly what the status of the inspection actually is.

Throughput time – The time required for a product to proceed from concept to launch, order to delivery, or raw materials into the hands of the customer. This includes both processing and queue time. Contrast with **processing time** and **lead time**.

Lean IR: The time required from the first problem that is found in the field, to the time of completion of the data entry in the computer for report generation.

Visual Controls – The placement in plain view of all tools, parts, production activities, and indicators of production system performance, so the status of the system can be understood at a glance by everyone involved.

Lean IR: By using visual controls correctly it is possible to quickly convey a lot of information very easily. These visual control allow for a transparency that helps in eliminating errors. The ability to provide at one glance the location of the equipment that is to be tested as well as the test status and the problem status in the route/inspection list. The ability to see the test status on equipment in the problem list.