* Introduction

Construction in Brazil is growing since the beginning of 20th Century, opening markets for many worldwide companies as well as for different technologies.

Concremat Engineering followed this huge growing and continue developing new markets with a state of the art engineering consultancy services, bringing intelligence, innovation and, especially, winning the confidence of its clients, always working with competence and transparency.

BMW New Plan Brazil Project is one special case of success where Concremat brought new ideas and advanced technology to the construction project such as Lean Construction, 4D Planning, Management Tools, Control Tools, receiving the best feedback from the client and becoming a benchmark and reference project inside BMW Worldwide. Concremat is also always looking for the future as well as for the environmental issues, where this case of success is receiving the best possible practices even without pursue of a certification, but always beyond the excellence in all the steps of the project.

* Innovation, quality and professional excellence

- Lean Construction – Takt Planning

The concept of the Project is the Lean Construction Methodology. This was a mandatory item since the bidding process and was included on the RFP. Following this Methodology, the team use the system of “Just in Time”, developing the principals of production flow, takt time (production rhythm), pull of production (one service starts after the other finish) and zero defect (stabilize and standard the process).

For this lean process, the focus was on the value, synchronicity, transparency and perfection, meaning that we had the reduction of the cost based on the detail material and execution logistics as well as the minimum waste of material and work force. The team measure everything in detail since the daily progress and team productivity until the logistic plan and time schedule update in real time. In this project we also avoid the re work and construction defects, big areas for storage, waste of material and waste of production time.

The total construction is divided in LOTs and each LOT has its own team, as there are many buildings and areas (infrastructure) spreading on the total Core Area. All LOTs are following the takt planning, and each building is divided in many takts as well as the roads and undergrounding utilities. Each lot has its own Control Board and each lot has its own Project and Construction Manager, where the first is responsible for the projects and interface with client areas and the second is responsible for the construction and interface with the contracted company.

The communication is constant and it allows the team to identify the interface or problems in a very fast way, as well as the quality problems. The objective and the planning are aligned between all involved parties and it makes easy to find solutions and make definitions. Action plans and counter measures are easy to create as well as to take difficult decisions and all these points are displayed on the Control Board.

The team also manage the costs based on the takt planning meaning that the client make the payments after a takt (area) is completed. It works for all different types of services from foundations to superstructure, from civil works to installation services, all divided in areas and each area with its own detail schedule of services. A Control Board
located on the field right next to the construction buildings shows the daily and weekly progress of all areas showing the transparency of the progress for all involved parties as well as the KPIs of all involved services.

The client provide workshops from three to three months, recycling the principles of the lean methodology, developing new ideas and sharing knowledge between all the managers and engineers involved directly in the Project. After the workshops, the managers revise all the discussed points and they become in lessons learned where it’s an improvement for the next projects.

**Key advantages of Lean Construction -** reduction in the main timeline of the project (and hence cost) due to the work occur through well-defined sequence in the application of resources (materials, labor, equipment) "just in time".
4D Planning consists in the process of integrating a 3D modeling with construction management schedules. This integration is done using specific software.

The methodology adopted by CONCREMAT is the use of BIM Modeling for the 3D model, allowing the team to make use of the information assigned to the model to provide faster integration during 4D process.

Through benchmarks, we are able to acknowledge that one of the main problems of construction management consists of communication issues. This mainly happens because of the amount of technical problems that might surround the process, allowing possible issues to be sought not further from its execution. 4D planning acts to produce a reduction of this communication problem.

Since this methodology consists of reading construction management documents, the team introduces the capability of proactively notifying BMW of possible inconsistencies, allowing the reduction of problems that might appear further in time.

The team develop the model based on 4 Planning, meaning this model will not be manage with the objective of producing technical design products. The methodology adopted for Modeling is BIM, with the use of Revit software to allow the use of information for later improve the 4D integration with the construction management schedule.

This model considers architectural and structural information of the design for its production. Its organization is based upon the construction management schedule to produce compatible models for 4D integration.

The integration of 3D Model and Construction Management schedule is done after the Modeling is finished. This integration will allow a group of analysis that include but are not limited to:

- Construction sequence analysis using a report to acknowledge the planning team of possible construction problems that might happen;
- Planning scenarios analysis with specific software and production of videos and images to allow graphical visualization of different schedule possibilities;
- Constant update of current schedule to provide updated status of 4D planning documents.
- Videos of Baseline schedule;
- Images of estimated status of construction site, defined according to kickoff meeting

Key advantages of 4D Planning - easy viewing of construction progress by leaders of the customer and helps in making strategic decisions.

NEW BMW PLANT BRAZIL
WEEK 25 – CAM 01
- Real Time Updated Time Schedule (Team Member)

The Team Member is designed to record status on its tasks without the need to learn an enterprise project management application. The Team Member allows the field engineers to quickly access and update the daily tasks using the platform or device that suits their needs.

Concremat team uses the Team Member on the iPad to:

- Modify team view to display the task list by project and by status, including Active, Due, Overdue, Starred, or Completed;
- View a list of all the steps for a task. Add, edit, or delete steps to reflect the work more accurately. The field engineers can enter the percentage complete to show progress on a step;
- View predecessor and successor tasks related to a task and contact resources associated with related tasks;
- Communicate with the project manager or other team members through e-mail. If a picture helps illustrate the message, the user can also take a photo with the device and attach it to the e-mail;
- Communicate with the project manager about a task by viewing and posting messages with the Discussion feature. All messages are saved with the selected task and are visible in Team Member database;
- View documents associated with a task and contact resources associated with project documents.

Key Advantages of Team Member – the remote operation accelerates in updating schedules (just in time) and facilitates the management team.

IPad display example:
- Aerial Photogrammetry and Topographic Triple Check (Quality)

One of the new resources that helps the management of the project is related to the topographic services. One reason is that in an automotive factory, especially regarding BMW where there are many conveyors, pits and other equipment that deserve a very detail accuracy and where measurements in the millimeters deviation can have a big impact in the final installation assembly.

As the construction is divided per LOTs, and for each LOT there’s a different subcontractor for the main contractor, the idea was to have two topographic companies (one to perform and other to check). However, CONCREMAT understand that BMW should have its own topographic team, checking the contractor topographic services and helping the installation team.

This Topographic Triple Check inspections was a very good solution for the project where there’s no problem regarding differences of position even for construction, even for installation. Everything is under the same grid, the possible problems are identified in advance, and corrections are made on time, avoiding any kind of delay of the project.

At the same time, an aerial photogrammetry service was contracted in order to check possible settlements and to offer to the client a very special idea of the progress. The results, based on the pictures that are taken in a monthly basis are fantastic and it giver a real prospective of the construction as well as the trends for the next periods. In terms of infrastructure installation inside or outside the construction area, it also helps to take fast decisions as the aerial photo shows a big area around it.

Key Advantages of Aerial Photogrammetry and Topographic Triple Check – quality assurance
Non-Conformities Report in a construction project is one of the most items that must be followed in terms of quality control, showing the contractor the wrong things that must be fixed and reporting this to the client that the management is being well done.

To speed up the process of creation the Non-Conformity, the field’s engineers uses the IPad as a very important tool, not just regarding time schedule control, but also regarding quality control. With this tablet, it’s easy to identify the Non-Conformity, describe it and take picture in a real time, sending the information online to the Contractor. It avoids also any kind of mistrust for the involved parties and helps the process to run in a very smooth and transparent way.

Main advantages of the tool - use remote accelerates the creation and correction of non-conformities (just in time), facilitates the management team in addition to quality assurance.

### NON CONFORMITY REPORT

<table>
<thead>
<tr>
<th>NCR_ID (Nº)</th>
<th>NCR_097</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATE</td>
<td>2014-06-16</td>
</tr>
<tr>
<td>LOT/SITE</td>
<td>LOT 2</td>
</tr>
<tr>
<td>AREA,LOCATION</td>
<td>(L2)-Body Store</td>
</tr>
<tr>
<td>PROCESS (SERVICE)</td>
<td>(GEN)-Quality</td>
</tr>
<tr>
<td>DESCRIPTION:</td>
<td>Dock levellers are stored in an inapropriated area. The equipments are damaged due to not store it properly.</td>
</tr>
</tbody>
</table>

PHOTO

![IMG_8031.JPG](IMG_8031.JPG)
* The principles of transparency and integrity

- Control Board (field and office)

One of the main tools of the Lean Construction is the Control Board. This is a tool used on the field as well in the office, showing many important information regarding production, action plan, time schedule, graphs and KPIs. This is a daily used tool and it shows to everybody the status of the construction and at the same time, the interference problems and counter measures for a possible delay. The Contractor uses the tool with its subcontractor and by the Client/Management Company with the Contractor.

Main advantages of the Control Board - transparency of information and goals, integration and interface between teams.
- Monthly/Weekly Report using the Think Project

For BMW Project it is mandatory since the design phase until the handover the use of Think Project Platform. This is a BMW standard and is used for drawings, minutes of meetings, documents, reports, and any kind of register regarding the executed services. The client is spreading all over the world and the directors can download all the documents from everywhere just having an internet connection. Based on this, the BMW standard reports are presented in a weekly and monthly basis, being very important to follow the progress of the project as well and to take important and management decisions, especially if the project is running out of the planned curve. All the information regarding progress, costs, cash flow, deviation, action plan and counter measures are presented on the reports and it shows the completely transparency of the information to all involved.

Key advantages of Monthly / Weekly - important information for the leaders of the client (such as time, cost, risk, quality, organization, communication, safety, environment and action plans) and helps in making strategic decisions.
A picture report is shared to all involved parties in a weekly basis where everybody for the client, even outside of the country can access the platform Think Project and have a real progress of the construction. It also compares the real construction status with the planned one, and it helps the client to take management decisions based in a real and transparent report.

Main advantages of Picture report - transparent communication through visual resources.

**PA-64 - NEW BMW PLANT BRAZIL WEEK 24 – PAINTSHOP & STACKER.**

**Paintshop & Stacker**
General View
Status: 16.06.2014

**PA-64 - NEW BMW PLANT BRAZIL WEEK 24 – BODYSTORE & STACKER.**

**Bodystore / Stacker**
General View
Status: 16.06.2014
* Sustainability and respect for the environment

The BMW project is not pursue any kind of certification regarding environment or sustainability but CONCREMAT is following the related services and implementing many activities that protect the environment. Some of the activities and counter measures regarding the environmental protection are:

- Prioritization of reuse discarded in soil terrain itself;
- Protection of slopes and hillsides avoiding erosion / executable rights of interim drainage network on the ground;
- Humidification of internal roads to avoid dust in excess;
- Vehicle inspection to identify possible leaks and soil contamination;
- Periodic collection of samples of the surface water and groundwater for analysis;
- Treatment of wastewater from the construction area/offices;
- Water reuse (from the construction offices) systems in the greenway;
- Construction material’s storage without soil contact;
- Use of small wood boxes for producing mortar or cement;
- Appropriate small containers for selective collection;
- Central waste bays separated by class of service on the working front;
- Signs in storage area;
- Waste sorting fronts Service;
- Singed storage of hazardous waste in a protected and ventilated place;
- Maximum recycling and reuse of general waste material generated at construction site;
- Reuse of scrap materials;
- Smoking free areas inside buildings;
- Use of PPE during activities that generate dust and apply products with VOCs;
- Humidification location during cleaning;
- Paint cans closed when not used;
- Control of energy consumption - with Procel symbol refrigerators and fluorescent lamps;
- Control of water consumption - Awareness to reduce water consumption;
- Control of lower environmental impact associated materials - paints and water biodegradable cleaning products;
- Monitoring of compliance (Non-Conformities) with conditions of the Environmental Permits;
- Control of licensing for waste receivers;
- Control of Waste Manifests;
- Preparation of Emergency Plan in case of soil contamination;
- Records of incidents and non-conformities;
- Control spreadsheet registration of environmental liabilities
Environmental Training

Rescue flora performed by qualified technicians and appropriately.