Escola d'Enginyeria de Telecomunicació i Aeroespacial de Castelldefels

UNIVERSITAT POLITÈCNICA DE CATALUNYA

MASTER THESIS

TITLE: CREATION OF A STANDARD ONLINE PERSONALIZATION ACCESS SERVER

MASTER DEGREE: Master in Science in Telecommunication Engineering & Management

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EXECUTIVE SUMMARY

Reorganizing and recreating the entire software infrastructure along with a deep study of production optimization, a detailed view of the possible actions to be performed will be analyzed. The following main areas are the objective of this project:

- Reduced delivery time to the customer (SLA)
- Increased production capacity of the personalization center
- Possible changes in equipment to improve the response of the two anterior points

The deadline delivery for La Caixa is at 13h30 every day, but with this project, production will now be able to deliver the cards at 11h40 instead of 13h30. That is a 13.52% gain of delivery time. The delivery percentage gain time for BBVA is 10.85% and production will be able to send the cards more than one hour before. The third and final client is Santander Universities. The delivery time is at 11:00am and now the cards will be able to be delivered at 9:56am, which is a 9.61% gain.

Just by saving the time for the operator of going to a quality control station, and by optimizing the machine, for La Caixa EMV cards, the actual production capacity gain per month is increased to 24585 cards. The machine performance increased from 10 cards per hour to 13.25 cards per hour. For La Caixa Contactless, the production that is gained is of 10250 cards per month. The time savings to produce the same production per month is approximately 7000 minutes. The machine performance increased from 10.29 cards/min to 13.85 cards/min. The total production gain for La Caixa is approximately 35000 cards per month.

For BBVA EMV, the production that is gained is of 12787 cards per month. The time savings to produce the same production per month is approximately 6000 minutes. The machine performance increased from 11.25 cards/min to 14.4 cards/min. For BBVA Contactless, the production that could be gained is of 8435 cards per month. The time savings to produce the same production per month is approximately 9200 minutes. The machine performance increased from 8 cards/min to 12 cards/min. The total production gain for BBVA is approximately 21000 cards per month.

For Santander Universities, the production that could be gained is of 12565 cards per month. The time savings to produce the same production per month is approximately 13840 minutes. The machine performance doubled from 4.5 cards/min to 9 cards/min.

By just adding two more embossers, the total throughput of the machine increases by 42%. The performance will be seen for all clients. Six stations installed corresponds to 700 cards per hour for BBVA Contactless, 900 cph for La Caixa Contactless, 1100 cph for BBVA EMV and La Caixa EMV. The Barcelona production floor has never seen machines with this performance ever since the site was created.

I. INTRODUCTION

In an increasingly connected society, the telecommunication and banking sector are rising every year and the technology keeps improving. From banking cards, such as VISA and MasterCard, to contactless cards, to be able to pay from your phone, the world has become more and more vulnerable for thieves to steal personal information. The leading digital security companies need to have controlled technologies in order to make digital interactions secure and easy. Billions of people worldwide increasingly want the freedom to communicate, travel, shop, bank, entertain, and work – anytime, anywhere – in ways that are convenient, enjoyable and secure.

Working for the world leader in digital security, the delivery of the people's needs for personal mobile services, identity protection, payment security, M2M communication and much more, is of excellence. This company spans the entire process for creating digital security solutions that embed the trust of its clients and customers. They develop secure operating systems and run them on trusted device, like smart cards, banking cards and other devices, which they assemble and personalize. They also deploy software that manage these devices, and innovate so their clients can offer more ways of enhancing the convenience and security of their end-users' digital lives.

The business offers personalized customer service very fast, with just a few hours to process, and a commitment to always deliver on time (over 99.5%). Customer satisfaction is the most important and essential for the business to stay on the market. If the delivery time is passed, this could result in significant penalties. Therefore, the company needs to make sure that the productive system is at its optimum at all times. Being at the maximum performance, means that the company can improve its production, without increasing equipment and resources.

Due to the nature of the product, the systems are based on industry specific software modules and encryption to ensure the confidentiality and to limit access to sensitive data. It is the duty to optimize the industrial installation of these "tools" and software to get the best production performance. The constant evolution of this software, due to customer requirements and improvements in security issues, requires constant revisions of the basic infrastructure to obtain the optimal performance. Today, the personalization center is not at its maximum and in the past year, the production has increased a lot and this resulted in the need for a thorough review of the company's systems.

Reorganizing and recreating the entire software infrastructure along with a deep study of production optimization, a detailed view of the possible actions to be performed will be analyzed. The following main areas are the objective of this project:

- Reduced delivery time to the customer (SLA)

- Increased production capacity of the personalization center
- Possible changes in equipment to improve the response of the two anterior points

In consequence, after working and collaborating with this company for a long period of time, and gaining the interest of realizing the final project in this business, they have decided to perform this study using their internal structure. This vision will give them important indicators for decision making in order to improve the three areas described above.

II. ONLINE PERSONALIZATION ACCESS SERVER

The Online Personalization Access Server, or OPERAS, is a tool that provides security services in environments with high security requirements. The goal of the OPERAS Server Application is to provide online services to personalization devices. It is hosted by a centralized server and/or distributed on each production machine.

In the case of the project, the OPERAS configuration is local to each machine because this allows the production shop floor to not saturate the server if centralized. The picture below shows the typical local OPERAS configuration on a production floor, which also demonstrates how it is configured where my project took place.

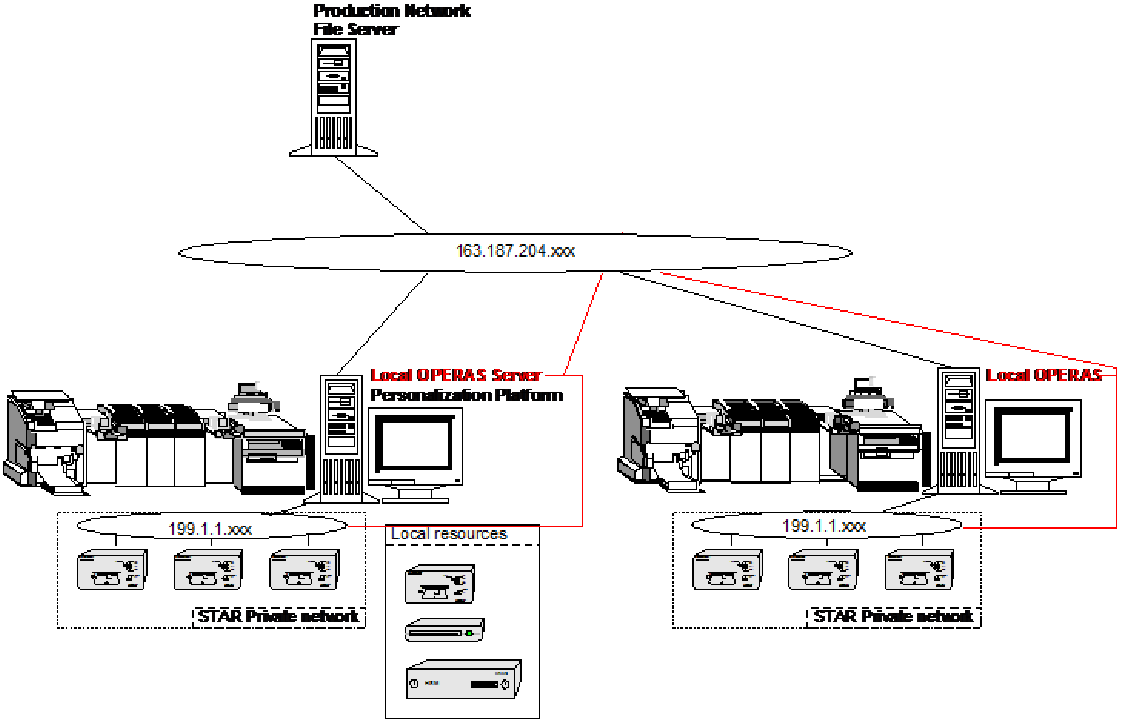

Figure 1. Operas Configuration

The OPERAS is a communication tool that helps the personalization stations connect to a server because the stations are on a dedicated network and cannot directly address a global server. The local OPERAS forwards all requests for a service that can be setup locally to a global server, in this case the key management system server.

The OPERAS is configured by a configuration file with an .ini extension called operas.ini, where all of the services are declared in, an operas library (operas.dll) started as a TCP/IP Server, and all of the services used with a terminology of OP_NameOf Service.dll with defined interface, which is being used by the server to make these libraries perform the needed tasks.

In order to have the best performance of all machines, the OPERAS need to be configured properly, optimizing the connections to the servers and its libraries. The personalization stations in each machine depend on that configuration because the better the configuration, the more stations can be installed, and better the performance of the machines.

Understanding the processes of OPERAS and how it actually works help in finding out the best configuration possible for each production site. For this project, a review of the configuration of all machines and of the entire infrastructure needed to be done in order to see what improvements could be accomplished to improve production.

III. STATE OF THE ART

The organization of the project was planned to first look up at the configuration of the OPERAS on the production shop floor. The machines consist of two computers, which one of them works with a windows operating system and the other with an OS2 operating system. The OPERAS can be found in a folder with all of its corresponding files in the windows platform.

I noticed that all of the machines had a different configuration, all with different number of files, different parameters in the operas.ini configuration file, and many unnecessary files. For this reason, the machines will freeze a lot at the connection between the key management server and the personalization stations and this is why this project was very valuable to the site.

The failure of the machines at the connection times brings difficulties in satisfying the client because of high percentage of card yield loss, which defines the amount of money lost to make one card and the increase of the SLA, which is the time the customer want the cards delivered. Also, by having a bad configuration means that the machines have a limited number of personalization stations and that affects directly to the performance of the machine, and therefore to the amount of production the shop floor can handle.

For all these reasons, this project of reinstating the infrastructure of the OPERAS connection is valuable for the satisfaction of the clients and the image of the company.

IV. UNDERSTAND HOW OPERAS WORK

When we talk about personalizing a card in this project, we actually mean that we are personalizing the chip of the card. This process is done when the card enters the personalization stations in the machine and these stations run what it is called a personalization script. The personalization scripts can vary between customers and between the types of card we want to produce.

The OPERAS comes into play at the personalization time because in the personalization scripts, OPERAS calls are defined. When the script reaches a line that calls for the OPERAS service, and then it searches in the folder where the operas is and uses that library to continue the script. For example, in one personalization script, let's just say that line 54 is of the form “OPE (DDA :...)”. OPE means that the script is looking for an operas service and therefore will go look in the operas configuration folder and will find a library called OP_DDA.dll. The content of the libraries is confidential and we do not have access, but the library will run and the personalization script will continue.

In the personalization scripts, there are many operas calls defined to different libraries, but there are also calls to the Key Management Server (KMS), where the keys are defined. This is necessary because in order to personalize the chip, decryption keys are needed in order to open the chip to personalize it. Usually, these keys are provided by the customer and are inserted in the KMS server by a mean of a key ceremony, which normally occurs every week for about one hour. During a key ceremony, production is affected and cannot produce because Security needs to stop the servers, and therefore access from the machines is impossible. This has been an issue for a long time that production cannot produce for about five hours per month, which really needed to be resolved as soon as possible. Production will lose these valuable hours and the SLA would not be reached most of the time. This project also consisted in arranging this part.

After the card has been personalized correctly in the machine, the operators run a control of the chip to see if the card was personalized for the right person. The operators have quality software that also run scripts called control scripts in order to check, using the production file, if the data in the chip corresponds to the cardholder. This software also uses the operas service, and just like the personalization scripts, the control scripts have OPERAS calls (“OPE (...)”) to different libraries.

As I mentioned earlier, all of the machines had a different operas configuration, the configuration files were badly named and wrongly configured, and that is why this project was decided to be implemented because production was really affected and this could result in us losing customers.

After I clearly understood how operas worked, I needed to start from scratch and create my own and clean new operas configuration. This was risky because if I would make a mistake in the operas configuration, then production will not be able to produce. In order to not affect production, I decided to first start for arranging the operas services of the control of the card because it is different from the personalization operas and I could create a new one from an external computer just by using the quality software. Once I would have the control created, I would pass on to create the personalization configuration.

V. NEW OPERAS CONTROL CONFIGURATION

In the production world, quality is very important. The operators are obliged to produce one card, to stop their current production, realize the quality check of the first card produced, and if “OK”, then they can continue their production.

While I was analyzing how production would realize a control, I noticed that the operators would make a card on one machine, but would realize the control of this card on external computer. I asked them why they go to another computer to make the control and they told me because on the machines, the control does not work. I looked at it and because the operas control services were not correctly configured, they could not realize the control on the machines.

I made an analysis of each machine and the operators’ path to realize the control and I realized that valuable time was lost during this process. We needed to take into account that the operators will make each path a round-trip because they had to go to the computer, realize the control, and come back. Sometimes, they even had to wait for another operator to finish, but in this project, I did not take this into account.

Depending on the customer and the card, this could reach a significant amount of time that the machine was not producing. This is why for this project, I decided to separate the analysis and to work with three different client (La Caixa, BBVA, and Santander Universities) and with two types of card (EMV, Contactless), which basically is regular chip and the new contactless technology. This initiative was decided because the operas services are different and each client has different personalization and control scripts, which vary in length and time.

To start off, I created two diagrams of the production shop floor along with the operators’ control routes for both chip (EMV) and Contactless cards. Below, the two diagrams are shown. The machines are in blue and the control stations are in red. As one can notice, the operators’ routes are different between EMV and Contactless. The fact that there are seven machines for three control stations makes it difficult to handle when a company is producing 300 000+ card per month.

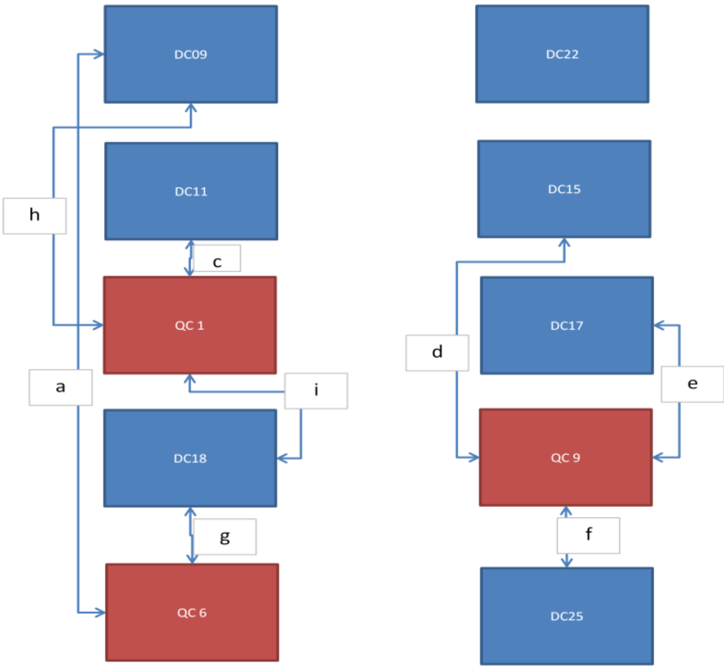

Figure 2. EMV Production Diagram

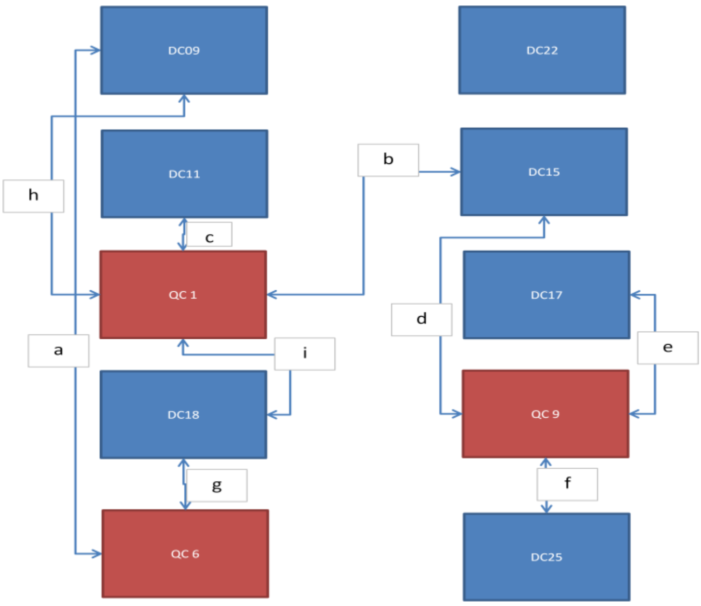

Figure 3. Contactless Production Diagram

The purpose of rearranging the operas configuration was to enable the operators to realize the control on each machine so that the time the machine was stopped would not be there because they would never leave it.

Now that I had a clear idea on what was the actual problem and how the operas service really worked, I decided to create from scratch a new operas control service on a separate computer, where production was not affected. There, I could just ask production to provide me with some produced cards, and I would test the new configuration to see if it worked correctly for all customers. In these types of master changes, I needed to make sure that all of the customers' cards would work with the new operas service.

In the production shop floor, there are about 15 control scripts and 40 personalization scripts. I knew that the operas calls always started by "OPE(XXX:...)", and therefore I had to go through each and every script and look for this beginning to find out what operas services production is actually using. I decided to create a macro in excel that would open every script and search for this pattern and that would give me all of the operas services that are in use nowadays. This saved me a lot of time and prevented from making a human error by maybe missing one service. The macro written is as followed:

```
Sub LET_FIND_IT_FOLDERS_SUBFOLDERS()

    Dim regex As Object
    Dim file  As Variant
    Dim lName As Long
    Dim lSize As Long
    Dim line  As String
    Dim bTrobat As Boolean

    Dim sNomFixter As String
    Dim lNumCopsTrobat As Long
    Dim sCadena As String
    Dim iContIni As Integer
    Dim iContFi As Integer
    Dim iContador As Integer

    Dim iFileStartToWrite As Integer
    Dim iColumnToFind As Integer
    Dim iPosFolderNameFile As Integer
    Dim iPosWordFindFile As Integer
    Dim lNumRows As Long

    Dim lNumRowIniFile As Integer 'On comença la part escrita del fitxer
    Dim lNumRowFinFile As Integer 'On finalitza la part escrita del fitxer

    Dim lContBuscarRepetits As Long
    Dim lNumRep As Long
    Dim bRepetit As Boolean


    iPosFolderNameFile = 3
    iPosWordFindFile = 5
    iFileStartToWrite = 10

    lNumRows = iFileStartToWrite

    'Aquestes s'hauran de posar dins del bucle quan faci búsqueda per tota la carpeta en general
    lNumRowIniFile = 10
    lNumRowFinFile = 10


    Dim sNomCarpeta As String
    Dim sFitxer As String

    sNomCarpeta = Cells(2, 2)

    'sFitxer = LeerCarpeta(sNomCarpeta)


Dim Ruta As String


    Dim colFiles As New Collection
    RecursiveDir colFiles, Cells(6, 2), "*.*", True

    Dim vFile As Variant
    For Each vFile In colFiles
        'Debug.Print vFile
```

```
        GoSub Fotli
    Next vFile

Exit Sub


Fotli:
        bTrobat = False

          Set regex = CreateObject("VBScript.RegExp")
          regex.Pattern = "^\s*(Name|Size):?(.*)$"
          regex.IgnoreCase = True
        'Aquí faré un for amb tots els fitxers de la carpeta
          With CreateObject("Scripting.FileSystemObject").OpenTextFile(vFile, 1, False)
            Cells(lNumRows, 1) = vFile
            Cells(lNumRows, 1).Font.Bold = True
            lNumRowIniFile = lNumRows
            'lNumRows = lNumRowIniFile
             While Not .AtEndOfStream
                'lNumRows = 0
                line = .ReadLine
                If InStr(1, line, "OPE(", vbTextCompare) > 0 _
                Or InStr(1, line, "OPE (", vbTextCompare) > 0 _
                Or InStr(1, line, "OPE  (", vbTextCompare) > 0 Then bTrobat = True 'Aquí després posaré una condició que busqui amb
un OR amb un espai en blanc la lletra "("   També puc dir-li que no busqui per 'OPE ...!!!!
                If bTrobat Then
                    ''MsgBox "hola"
                    GoSub BuscarSiEsRepetit
                    If Not bRepetit Then
                        Cells(lNumRows, 2) = line
                        Cells(lNumRows, 2).Font.Size = 8
                        Cells(lNumRows, 3) = 1 'Posem a 0 el número de registres que trobem repetits.
                        lNumRows = lNumRows + 1
                        lNumRowFinFile = lNumRows
                    End If
                    bTrobat = False
                End If
             Wend
             .Close
          End With
       'End If

   'Next archivo

Return

BuscarSiEsRepetit:

    bRepetit = False

    For lContBuscarRepetits = lNumRowIniFile To lNumRowFinFile

        If Cells(lContBuscarRepetits, 2) = line Then
            Cells(lContBuscarRepetits, 3) = Cells(lContBuscarRepetits, 3) + 1
            bRepetit = True
        End If

    Next lContBuscarRepetits

Return

End Sub
Private Sub merda()

    Dim colFiles As New Collection
    RecursiveDir colFiles, Cells(2, 2), "*.per", True

    Dim vFile As Variant
    For Each vFile In colFiles
        Debug.Print vFile
    Next vFile

End Sub
Public Function RecursiveDir(colFiles As Collection, _
                             strFolder As String, _
                             strFileSpec As String, _
```

```
                         bIncludeSubfolders As Boolean)

    Dim strTemp As String
    Dim colFolders As New Collection
    Dim vFolderName As Variant

    'Add files in strFolder matching strFileSpec to colFiles
    strFolder = TrailingSlash(strFolder)
    strTemp = Dir(strFolder & strFileSpec)
    Do While strTemp <> vbNullString
        colFiles.Add strFolder & strTemp
        strTemp = Dir
    Loop

    If bIncludeSubfolders Then
        'Fill colFolders with list of subdirectories of strFolder
        strTemp = Dir(strFolder, vbDirectory)
        Do While strTemp <> vbNullString
            If (strTemp <> ".") And (strTemp <> "..") Then
                If (GetAttr(strFolder & strTemp) And vbDirectory) <> 0 Then
                    colFolders.Add strTemp
                End If
            End If
            strTemp = Dir
        Loop

        'Call RecursiveDir for each subfolder in colFolders
        For Each vFolderName In colFolders
            Call RecursiveDir(colFiles, strFolder & vFolderName, strFileSpec, True)
        Next vFolderName
    End If

End Function


Public Function TrailingSlash(strFolder As String) As String
    If Len(strFolder) > 0 Then
        If Right(strFolder, 1) = "\" Then
            TrailingSlash = strFolder
        Else
            TrailingSlash = strFolder & "\"
        End If
    End If
End Function
```

When this macro is executed, all of the “OPE(XXX:...)” lines in all of the control scripts are shown in an excel sheet. This allowed me to create an excel and to register which services were used. I went on the website to download the operas services and their latest versions. I also had to read all of the libraries specifications because some libraries are related with others and no files could be missing in the configuration. I learned a lot about the operas services, their functions, and which type of error I could encounter with their specific code error.

During that time, I became an expert in solving chip errors for production because just by looking at the code error, I was able to deduct where the error was coming from. I gained valuable experience in this field and had an advantage on most of the employees in knowing this information.

Having read all of the specifications of each service used, I needed to configure the most important file for the operas which was the operas.ini. This file was not really complicated to build, but no errors could have been made. A .ini file can be created on notepad, and I created mine from scratch. I knew which services were used and I had read the information given on the company’s website, I was able to create the operas.ini file with the correct configuration. With the new operas configuration folder created for the control only, I went to the external computer and I tried to control cards from every client. At first, I was having problems in that all the cards were saying "NOK". This meant that some data was missing to check because production already had done the control of these cards and it had given "OK" on their quality control station. Analyzing the error, I noticed that I was missing the CAPK certificates. These certificates are defined in the Registry of each windows computer and define some parameters. These certificates need to be updated every three years, for example, because of the expiry date of the card.

Another important step needed to be done and these certificates had to be updated because some of them were missing. Talking with technical consultant and customer service, I was able to get the missing certificates and I created a file with a .reg extension in the network so that when an update is needed, only this file has to be updated and executed.

Finally, having the right certificates, the correct operas services, the correct operas.ini file and some necessary files to complete the installation, the quality control for all clients worked with the new configuration and I decided to implement this new standard on the production shop floor but only on the three quality control stations because the personalization part was missing.

Having the new standard implemented for quality control, I analyzed how much time and distance the operators would lose per card controlled per client and per type of card. The new configuration was not implemented yet on the machines but once it would be, then these times would be reduced significantly, therefore I anticipated and compared the before, which was with the operas not implemented on the machines, and after, which was with the new operas implemented on the machines. Below, one can see the tables that show this data.

BEFORE					
	ITINERARY	DISTANCE TIME (secs)	DISTANCE TIME (mins)	CONTROL TIME/CARD (secs)	CONTROL TIME/CARD (mins)
LA CAIXA EMV	a	10	0.17	10	0.17
	d	7	0.12	10	0.17
	e	5	0.08	10	0.17
	f	5	0.08	10	0.17
	g	5	0.08	10	0.17
LA CAIXA CLESS	a	10	0.17	16	0.27
	d	7	0.12	16	0.27
	g	5	0.08	16	0.27
	e	5	0.08	16	0.27
	f	5	0.08	16	0.27

AFTER					
	ITINERARY	DISTANCE TIME (secs)	DISTANCE TIME (mins)	CONTROL TIME/CARD (secs)	CONTROL TIME/CARD (mins)
LA CAIXA EMV	NO	0	0.00	10	0.17
	NO	0	0.00	10	0.17
	NO	0	0.00	10	0.17
	NO	0	0.00	10	0.17
	NO	0	0.00	10	0.17
LA CAIXA CLESS	NO	0	0.00	16	0.27
	NO	0	0.00	16	0.27
	NO	0	0.00	16	0.27
	NO	0	0.00	16	0.27
	NO	0	0.00	16	0.27

Table 1. La Caixa EMV and Contactless Time and Distance Lost

BEFORE					
	ITINERARY	DISTANCE TIME (secs)	DISTANCE TIME (mins)	CONTROL TIME (secs)	CONTROL TIME (mins)
BBVA EMV	c	5	0.08	16	0.27
	h	7	0.12	16	0.27
	i	6	0.10	16	0.27
	d	7	0.12	16	0.27
BBVA CLESS	c	5	0.08	30	0.50
	h	7	0.12	30	0.50
	i	6	0.10	30	0.50
	b	10	0.17	30	0.50
	d	7	0.12	30	0.50

AFTER					
	ITINERARY	DISTANCE TIME (secs)	DISTANCE TIME (mins)	CONTROL TIME (secs)	CONTROL TIME (mins)
BBVA EMV	NO	0	0.00	16	0.27
	NO	0	0.00	16	0.27
	NO	0	0.00	16	0.27
	NO	0	0.00	16	0.27
BBVA CLESS	NO	0	0.00	30	0.50
	NO	0	0.00	30	0.50
	NO	0	0.00	30	0.50
	NO	0	0.00	30	0.50

Table 2. BBVA EMV and Contactless Time and Distance Lost

BEFORE					
	ITINERARY	DISTANCE TIME (secs)	DISTANCE TIME (mins)	CONTROL TIME (secs)	CONTROL TIME (mins)
SANTANDER UNIVERSITIES	b	10	0.17	30	0.50

AFTER					
	ITINERARY	DISTANCE TIME (secs)	DISTANCE TIME (mins)	CONTROL TIME (secs)	CONTROL TIME (mins)
SANTANDER UNIVERSITIES	NO	0	0.00	30	0.50

Table 3. Santander Universities Contactless Time and Distance Lost

As noticed, there is approximately 50% difference between the BEFORE and AFTER, and this can be converted in lost production. The following tables will show the amount of production lost during the time difference between AFTER and BEFORE.

BEFORE			AFTER		
CLIENTS	ITINERARY	TOTAL CONTROL TIME/CARD (mins)	CLIENTS	ITINERARY	TOTAL CONTROL TIME/CARD (mins)
LA CAIXA EMV	a	0.50	LA CAIXA EMV	NO	0.17
	d	0.40		NO	0.17
	e	0.33		NO	0.17
	f	0.33		NO	0.17
	g	0.33		NO	0.17
VOLUME		78.30	VOLUME		78.30
AVERAGE CONTROL TIME/DAY (mins)		**29.75**	AVERAGE CONTROL TIME/DAY (mins)		**13.05**
BBVA EMV	c	0.43	BBVA EMV	NO	0.27
	h	0.50		NO	0.27
	i	0.47		NO	0.27
	d	0.50		NO	0.27
VOLUME		19.00	VOLUME		19.00
AVERAGE CONTROL TIME/DAY (mins)		**9.03**	AVERAGE CONTROL TIME/DAY (mins)		**5.07**
AVERAGE CONTROL TIME FOR ALL CLIENTS EMV (mins)		**0.40**	**AVERAGE CONTROL TIME FOR ALL CLIENTS EMV (mins)**		**0.19**

Table 4. Average Control Time For All EMV

BEFORE			AFTER		
CLIENTS	ITINERARY	TOTAL CONTROL TIME /CARD(mins)	CLIENTS	ITINERARY	TOTAL CONTROL TIME/CARD (mins)
LA CAIXA CLESS	a	0.60	LA CAIXA CLESS	NO	0.27
	d	0.50		NO	0.27
	e	0.43		NO	0.27
	f	0.43		NO	0.27
	g	0.43		NO	0.27
VOLUME		47.77	VOLUME		47.77
AVERAGE CONTROL TIME/DAY (mins)		**22.93**	AVERAGE CONTROL TIME/DAY (mins)		**12.74**
BBVA CLESS	c	0.67	BBVA CLESS	NO	0.50
	h	0.73		NO	0.50
	i	0.70		NO	0.50
	d	0.73		NO	0.50
	b	0.83			
VOLUME		7.00	VOLUME		7.00
AVERAGE CONTROL TIME/DAY (mins)		**5.13**	AVERAGE CONTROL TIME/DAY (mins)		**3.50**
SANTANDER UNIVERSITIES	b	0.83	SANTANDER UNIVERSITIES	NO	0.50
VOLUME		1.27	VOLUME		1.27
AVERAGE CONTROL TIME/DAY (mins)		**1.06**	AVERAGE CONTROL TIME/DAY (mins)		**0.63**
AVERAGE CONTROL TIME FOR ALL CLIENTES CLESS (mins)		**0.52**	**AVERAGE CONTROL TIME FOR ALL CLIENTES CLESS (mins)**		**0.30**

Table 5. Average Control Time For All Contactless

The tables above show the average control time saving gained if the operators do the control on the machine for both EMV and Contactless. The time halved for both and with these calculations, I was able to convert that into lost production during this time, but also into the possible production gain capacity. With the help of the production center manager and quality team, the following calculations were deducted.

The graph below summarizes the saving time on the quality control process.

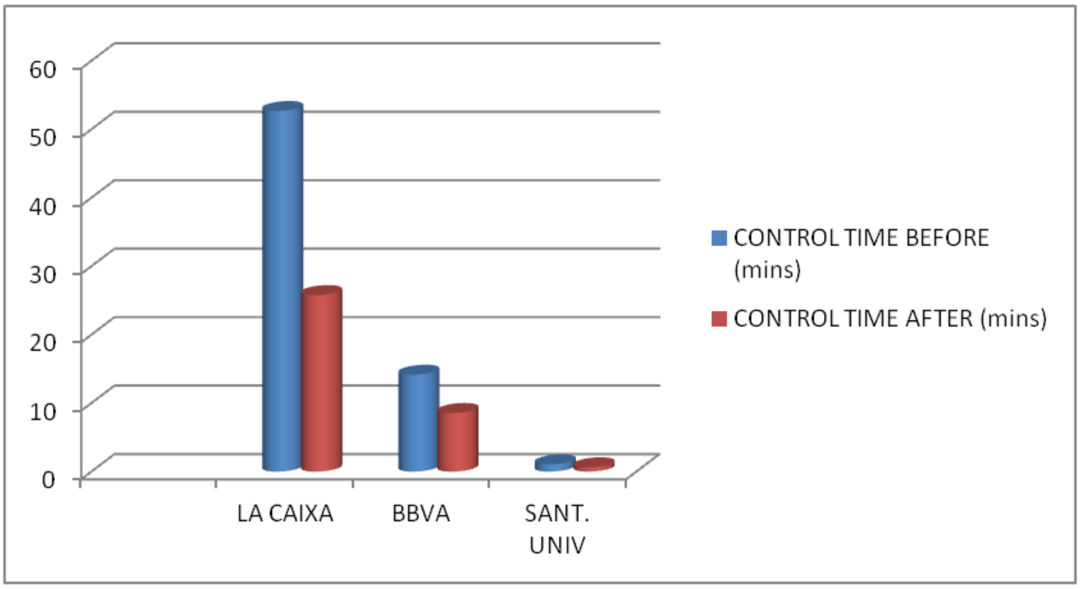

Figure 4. Average Control Time Before vs After

1. LA CAIXA EMV

BEFORE				
CLIENT: LA CAIXA EMV				
EFFECTIVE OPERADORS MINS / DAY	NUMBER OF BATCHES / DAY	NUMBER OF CONTROLLED CARDS / DAY	TOTAL CONTROL TIME / DAY (mins)	EFFECTIVE PRODUCTION TIME (mins)
1260.00	78.30	78.30	29.75	1230.25
MACHINE PERFORMANCE (cards/min)	PRODUCTION LOST DURING CONTROL TIME (cards)/DAY	TOTAL POSSIBLE PRODUCTION WITHOUT EFFECTIVE PROD TIME/DAY(cards)	POSSIBLE PRODUCTION/DAY (cards)	TIME IT TAKES TO PRODUCE POSSIBLE PROD /DAY(mins)
10.00	297.54	12600.00	12302.46	1230.25
ACTUAL PRODUCTION TODAY/MONTH (cards)	TIME IT TAKES TO PRODUCE PRODUCTION TODAY/DAY (mins)			
60941	**277**			

AFTER				
CLIENT: LA CAIXA EMV				
EFFECTIVE OPERADORS MINS / DAY	NUMBER OF BATCHES / DAY	NUMBER OF CONTROLLED CARDS / DAY	TOTAL CONTROL TIME / DAY (mins)	EFFECTIVE PRODUCTION TIME (mins)
1260.00	78.30	78.30	13.05	1246.95
MACHINE PERFORMANCE (cards/min)	PRODUCTION LOST DURING CONTROL TIME (cards)/DAY	TOTAL POSSIBLE PRODUCTION WITHOUT EFFECTIVE PROD TIME/DAY(cards)	POSSIBLE PRODUCTION/DAY (cards)	TIME IT TAKES TO PRODUCE POSSIBLE PROD /DAY(mins)
13.85	180.69	17446.15	17265.46	1273.19
PRODUCE SAME PRODUCTION/DAY (cards)	TIME IT TAKES TO PRODUCE SAME PRODUCTION/DAY (mins)	ACTUAL PRODUCTION TODAY/MONTH (cards)	TIME IT TAKES TO PRODUCE PRODUCTION TODAY/DAY (mins)	
12302	**889**	60941	**200**	

BEFORE VS AFTER							
PRODUCTION GAIN/DAY (cards)	PRODUCTION GAIN/DAY(%)	**PRODUCTION CAPACITY GAIN/MONTH**	**ACTUAL PRODUCTION CAPACITY GAIN/MONTH**	**TIME SAVINGS TO PRODUCE SAME PRODUCTION/MONTH (mins)**	**TIME SAVINGS TO PRODUCE PRODUCTION TODAY/DAY (mins)**	**TIME SAVINGS TO PRODUCE PRODUCTION TODAY/DAY (%)**	**ACTUAL PRODUCTION CAPACITY GAIN/MONTH**
4963.00	40.34%	**109186**	**24585**	**7518.17**	**77**	**27.78%**	**27585**

Table 6. La Caixa EMV Production gain

Looking at the tables above, just by saving the time for the operator of going to a quality control station, and by optimizing the machine, for La Caixa EMV cards, the actual production capacity gain per month would be 24585 cards. This is taking into account the new operas configuration on each machine with the optimized number of personalization stations. The machine performance increased from 10 cards per hour to 13.25 cards per hour with the new configuration. These calculations were done after implementing the new operas on the machines.

The same calculations were done for BBVA EMV, La Caixa Contactless, BBVA Contactless and Santander Universities (only contactless).

2. BBVA EMV

BEFORE				
CLIENT: BBVA EMV				
EFFECTIVE OPERADORS MINS / DAY	NUMBER OF BATCHES / DAY	NUMBER OF CONTROLLED CARDS / DAY	TOTAL CONTROL TIME / DAY (mins)	EFFECTIVE PRODUCTION TIME (mins)
1260	19	19	9	1251
MACHINE PERFORMANCE (cards/min)	PRODUCTION LOST DURING CONTROL TIME (cards)/DAY	TOTAL POSSIBLE PRODUCTION WITHOUT EFFECTIVE PROD TIME/DAY(cards)	POSSIBLE PRODUCTION/DAY (cards)	TIME IT TAKES TO PRODUCE POSSIBLE PROD /DAY(mins)
11.25	102	14175.00	14073	1250.98
ACTUAL PRODUCTION TODAY/MONTH (cards)	TIME IT TAKES TO PRODUCE PRODUCTION TODAY/DAY (mins)			
45017	**182**			

AFTER				
CLIENT: BBVA EMV				
EFFECTIVE OPERADORS MINS / DAY	NUMBER OF BATCHES / DAY	NUMBER OF CONTROLLED CARDS / DAY	TOTAL CONTROL TIME / DAY (mins)	EFFECTIVE PRODUCTION TIME (mins)
1260	19	19	5	1255
MACHINE PERFORMANCE (cards/min)	PRODUCTION LOST DURING CONTROL TIME (cards)/DAY	TOTAL POSSIBLE PRODUCTION WITHOUT EFFECTIVE PROD TIME/DAY(cards)	POSSIBLE PRODUCTION/DAY (cards)	TIME IT TAKES TO PRODUCE POSSIBLE PROD /DAY(mins)
14.40	73	18144.00	18071	1265.09
PRODUCE SAME PRODUCTION/DAY (cards)	TIME IT TAKES TO PRODUCE SAME PRODUCTION/DAY (mins)	ACTUAL PRODUCTION TODAY/MONTH (cards)	TIME IT TAKES TO PRODUCE PRODUCTION TODAY/DAY (mins)	
14073	**977**	45017	**142**	

BEFORE VS AFTER							
PRODUCTION GAIN/DAY (cards)	PRODUCTION GAIN/DAY(%)	**PRODUCTION CAPACITY GAIN/MONTH**	**ACTUAL PRODUCTION CAPACITY GAIN/MONTH**	**TIME SAVINGS TO PRODUCE SAME PRODUCTION/MONTH (mins)**	**TIME SAVINGS TO PRODUCE PRODUCTION TODAY/DAY (mins)**	**TIME SAVINGS TO PRODUCE PRODUCTION TODAY/DAY (%)**	**ACTUAL PRODUCTION CAPACITY GAIN/MONTH**
3997.57	28.41%	**87947**	**12787**	**6020.32**	**40**	**21.88%**	**16162**

Table 7. BBVA EMV Production Gain

For BBVA EMV, the production that could be gained is of 12787 cards per month. The time savings to produce the same production per month is approximately 6000 minutes. The machine performance increased from 11.25 cards/min to 14.4 cards/min.

3. LA CAIXA CONTACTLESS

BEFORE				
CLIENT: LA CAIXA CLESS				
EFFECTIVE OPERADORS MINS / DAY	NUMBER OF BATCHES / DAY	NUMBER OF CONTROLLED CARDS / DAY	TOTAL CONTROL TIME / DAY (mins)	EFFECTIVE PRODUCTION TIME (mins)
1260.00	47.77	47.77	22.93	1237.07
MACHINE PERFORMANCE (cards/min)	PRODUCTION LOST DURING CONTROL TIME (cards)/DAY	TOTAL POSSIBLE PRODUCTION WITHOUT EFFECTIVE PROD TIME/DAY(cards)	POSSIBLE PRODUCTION/DAY (cards)	TIME IT TAKES TO PRODUCE POSSIBLE PROD /DAY(mins)
10.29	235.83	12960.00	12724.17	1237.07
ACTUAL PRODUCTION TODAY/MONTH (cards)	TIME IT TAKES TO PRODUCE PRODUCTION TODAY/DAY (mins)			
28691	**127**			

AFTER				
CLIENT: LA CAIXA CLESS				
EFFECTIVE OPERADORS MINS / DAY	NUMBER OF BATCHES / DAY	NUMBER OF CONTROLLED CARDS / DAY	TOTAL CONTROL TIME / DAY (mins)	EFFECTIVE PRODUCTION TIME (mins)
1260.00	47.77	47.77	12.74	1247.26
MACHINE PERFORMANCE (cards/min)	PRODUCTION LOST DURING CONTROL TIME (cards)/DAY	TOTAL POSSIBLE PRODUCTION WITHOUT EFFECTIVE PROD TIME/DAY(cards)	POSSIBLE PRODUCTION/DAY (cards)	TIME IT TAKES TO PRODUCE POSSIBLE PROD /DAY(mins)
13.85	176.37	17446.15	17269.78	1272.87
PRODUCE SAME PRODUCTION/DAY (cards)	TIME IT TAKES TO PRODUCE SAME PRODUCTION/DAY (mins)	ACTUAL PRODUCTION TODAY/MONTH (cards)	TIME IT TAKES TO PRODUCE PRODUCTION TODAY/DAY (mins)	
12724	**919**	28691	**94**	

BEFORE VS AFTER							
PRODUCTION GAIN/DAY (cards)	PRODUCTION GAIN/DAY(%)	**PRODUCTION CAPACITY GAIN/MONTH**	**ACTUAL PRODUCTION CAPACITY GAIN/MONTH**	**TIME SAVINGS TO PRODUCE SAME PRODUCTION/MONTH (mins)**	**TIME SAVINGS TO PRODUCE PRODUCTION TODAY/DAY (mins)**	TIME SAVINGS TO PRODUCE PRODUCTION TODAY/DAY (%)	**ACTUAL PRODUCTION CAPACITY GAIN/MONTH**
4545.62	35.72%	**100004**	**10250**	**6998.29**	**33**	**25.71%**	**13335**

Table 8. La Caixa Contactless Production Gain

For La Caixa Contactless, the production that could be gained is of 10250 cards per month. The time savings to produce the same production per month is approximately 7000 minutes. The machine performance increased from 10.29 cards/min to 13.85 cards/min.

4. BBVA CONTACTLESS

BEFORE				
CLIENT: BBVA CLESS				
EFFECTIVE OPERADORS MINS / DAY	NUMBER OF BATCHES / DAY	NUMBER OF CONTROLLED CARDS / DAY	TOTAL CONTROL TIME / DAY (mins)	EFFECTIVE PRODUCTION TIME (mins)
1260	7	7.00	5.13	1254.87
MACHINE PERFORMANCE (cards/min)	PRODUCTION LOST DURING CONTROL TIME (cards)/DAY	TOTAL POSSIBLE PRODUCTION WITHOUT EFFECTIVE PROD TIME/DAY(cards)	POSSIBLE PRODUCTION/DAY (cards)	TIME IT TAKES TO PRODUCE POSSIBLE PROD /DAY(mins)
8.00	41	10080.00	10039	1254.87
ACTUAL PRODUCTION TODAY/MONTH (cards)	TIME IT TAKES TO PRODUCE PRODUCTION TODAY/DAY (mins)			
16805	**95**			

AFTER				
CLIENT: BBVA CLESS				
EFFECTIVE OPERADORS MINS / DAY	NUMBER OF BATCHES / DAY	NUMBER OF CONTROLLED CARDS / DAY	TOTAL CONTROL TIME / DAY (mins)	EFFECTIVE PRODUCTION TIME (mins)
1260	7	7.00	3.50	1256.50
MACHINE PERFORMANCE (cards/min)	PRODUCTION LOST DURING CONTROL TIME (cards)/DAY	TOTAL POSSIBLE PRODUCTION WITHOUT EFFECTIVE PROD TIME/DAY(cards)	POSSIBLE PRODUCTION/DAY (cards)	TIME IT TAKES TO PRODUCE POSSIBLE PROD /DAY(mins)
12.00	42	15120.00	15078	1263.51
PRODUCE SAME PRODUCTION/DAY (cards)	TIME IT TAKES TO PRODUCE SAME PRODUCTION/DAY (mins)	ACTUAL PRODUCTION TODAY/MONTH (cards)	TIME IT TAKES TO PRODUCE PRODUCTION TODAY/DAY (mins)	
10039	**837**	16805	**64**	

BEFORE VS AFTER							
PRODUCTION GAIN/DAY (cards)	PRODUCTION GAIN/DAY(%)	**PRODUCTION CAPACITY GAIN/MONTH**	**ACTUAL PRODUCTION CAPACITY GAIN/MONTH**	**TIME SAVINGS TO PRODUCE SAME PRODUCTION/MONTH (mins)**	**TIME SAVINGS TO PRODUCE PRODUCTION TODAY/DAY (mins)**	**TIME SAVINGS TO PRODUCE PRODUCTION TODAY/DAY (%)**	**ACTUAL PRODUCTION CAPACITY GAIN/MONTH**
5039.07	50.20%	**110859**	**8435**	**9202.36**	**32**	**33.33%**	**10835**

Table 9. BBVA Contactless Production Gain

For BBVA Contactless, the production that could be gained is of 8435 cards per month. The time savings to produce the same production per month is approximately 9200 minutes. The machine performance increased from 8 cards/min to 12 cards/min.

5. SANTANDER UNIVERSITIES CONTACTLESS

BEFORE				
CLIENT: SANTANDER UNIVERSITIES CLESS				
EFFECTIVE OPERADORS MINS / DAY	NUMBER OF BATCHES / DAY	NUMBER OF CONTROLLED CARDS / DAY	TOTAL CONTROL TIME / DAY (mins)	EFFECTIVE PRODUCTION TIME (mins)
1260	1.266666667	1.27	1.06	1258.94
MACHINE PERFORMANCE (cards/min)	PRODUCTION LOST DURING CONTROL TIME (cards)/DAY	TOTAL POSSIBLE PRODUCTION WITHOUT EFFECTIVE PROD TIME/DAY(cards)	POSSIBLE PRODUCTION/DAY (cards)	TIME IT TAKES TO PRODUCE POSSIBLE PROD /DAY(mins)
4.50	5	5670.00	5665	1258.94
ACTUAL PRODUCTION TODAY/MONTH (cards)	TIME IT TAKES TO PRODUCE PRODUCTION TODAY/DAY (mins)			
12557	**127**			

AFTER				
CLIENT: SANTANDER UNIVERSITIES CLESS				
EFFECTIVE OPERADORS MINS / DAY	NUMBER OF BATCHES / DAY	NUMBER OF CONTROLLED CARDS / DAY	TOTAL CONTROL TIME / DAY (mins)	EFFECTIVE PRODUCTION TIME (mins)
1260	1.266666667	1.27	0.63	1259.37
MACHINE PERFORMANCE (cards/min)	PRODUCTION LOST DURING CONTROL TIME (cards)/DAY	TOTAL POSSIBLE PRODUCTION WITHOUT EFFECTIVE PROD TIME/DAY(cards)	POSSIBLE PRODUCTION/DAY (cards)	TIME IT TAKES TO PRODUCE POSSIBLE PROD /DAY(mins)
9.00	6	11340.00	11334	1260.63
PRODUCE SAME PRODUCTION/DAY (cards)	TIME IT TAKES TO PRODUCE SAME PRODUCTION/DAY (mins)	ACTUAL PRODUCTION TODAY/MONTH (cards)	TIME IT TAKES TO PRODUCE PRODUCTION TODAY/DAY (mins)	
5665	**629**	12557	**63**	

BEFORE VS AFTER							
PRODUCTION GAIN/DAY (cards)	PRODUCTION GAIN/DAY(%)	**PRODUCTION CAPACITY GAIN/MONTH**	**ACTUAL PRODUCTION CAPACITY GAIN/MONTH**	**TIME SAVINGS TO PRODUCE SAME PRODUCTION/MONTH (mins)**	**TIME SAVINGS TO PRODUCE PRODUCTION TODAY/DAY (mins)**	**TIME SAVINGS TO PRODUCE PRODUCTION TODAY/DAY (%)**	**ACTUAL PRODUCTION CAPACITY GAIN/MONTH**
5669.05	100.07%	**124719**	**12565**	**13848.39**	**63**	**50.00%**	**13915**

Table 10. Santander universities Production Gain

For Santander Universities, the production that could be gained is of 12565 cards per month. The time savings to produce the same production per month is approximately 13840 minutes. The machine performance doubled from 4.5 cards/min to 9 cards/min.

As one can notice, just by creating a new standard operas and allowing the operators to do the control on each machine, the production for each of these clients greatly increased. Taking into account that these savings can be looked at two different ways: First, the company does not need that many operators anymore and could take operators out of the shop floor and place them in another position to help out another department or tell the clients that they can send more volumes because we are now able to produce that much more.

The objective of the first part of the project was to make the life of the operators and the production shop floor easier, but also to help the company in its production volumes because the goal for 2013 is to increase Barcelona's production.

Below, the graphs represent better pictures of the numbers above for each client.

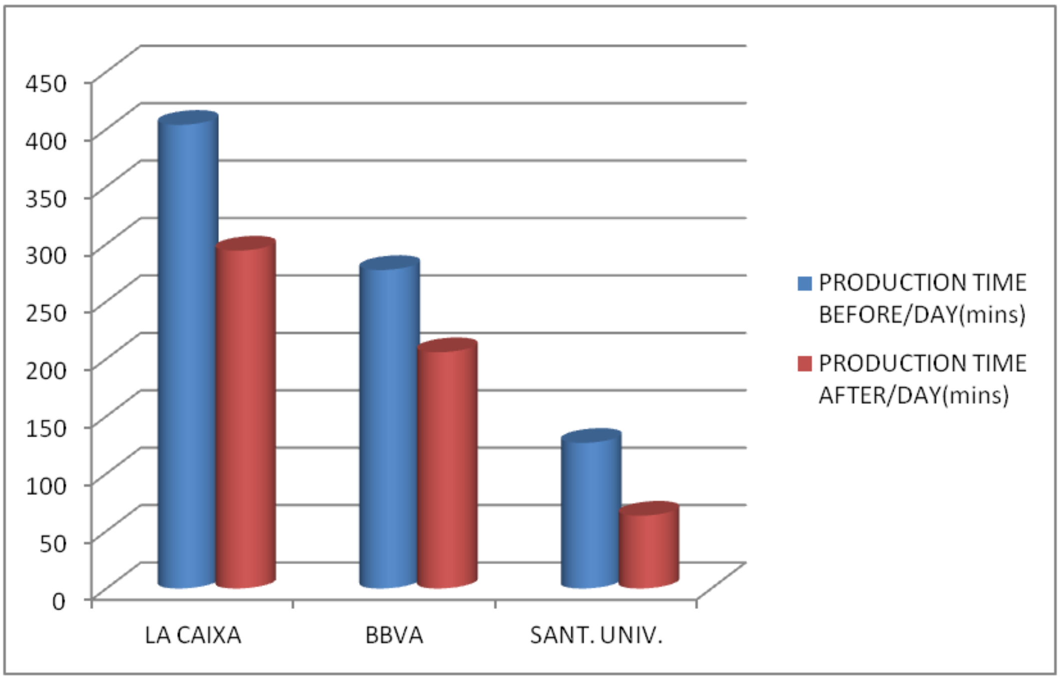

Figure 5. Production Time Saving For Each Client

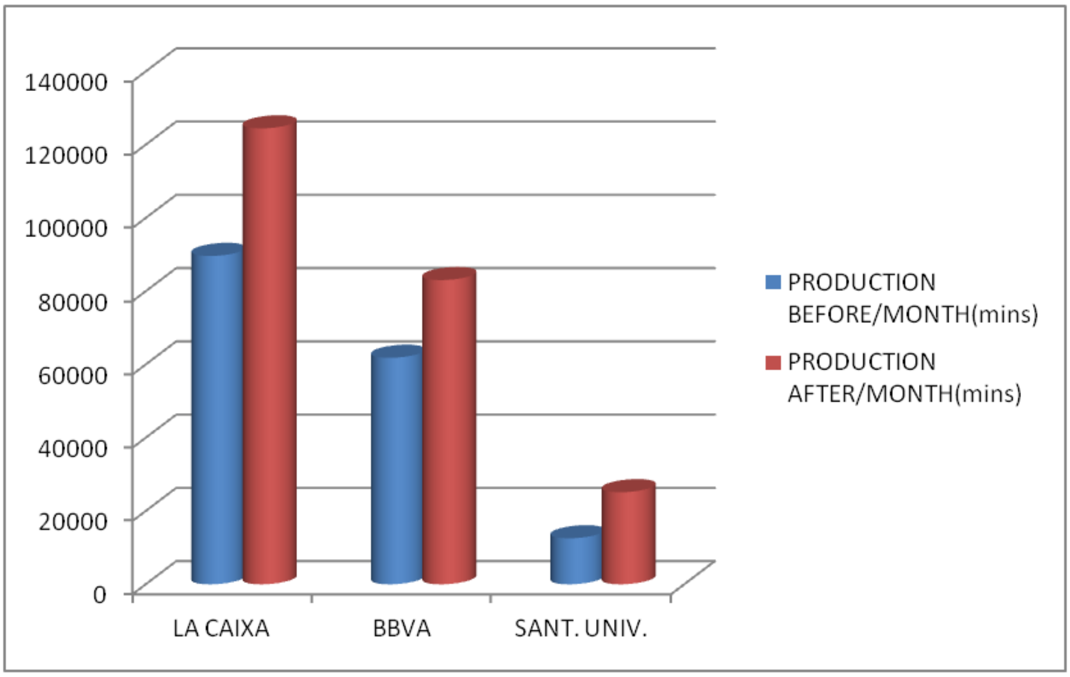

Figure 6. Production Gain Per Month

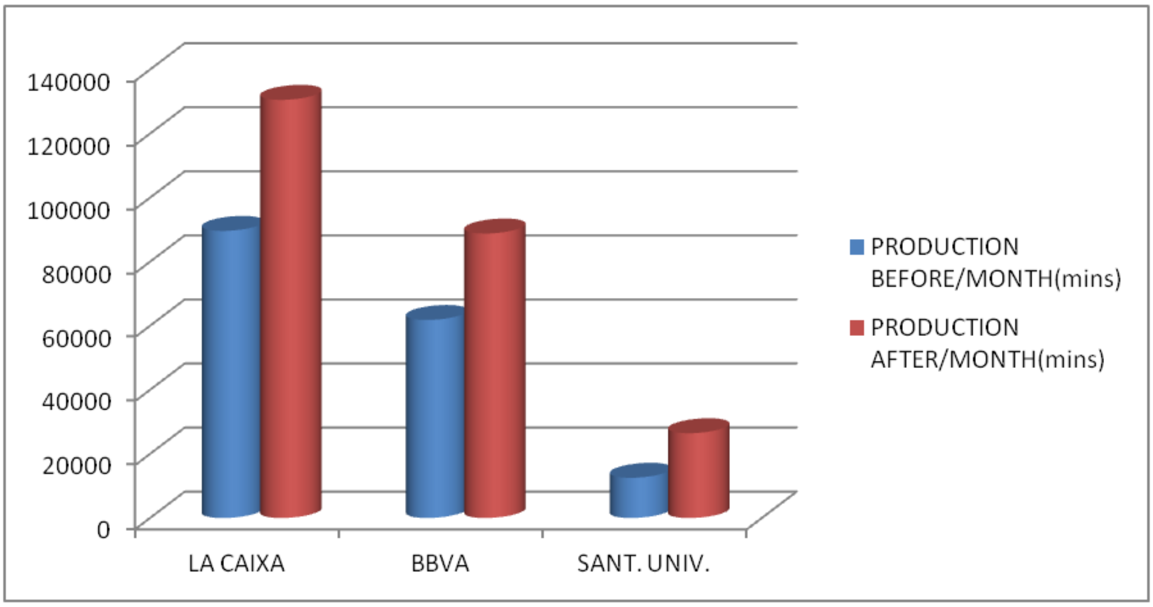

Figure 7. Production Gain With KMS Ceremony

In the graphs above, the red bar represents the configuration that this project changed. One can notice that in all aspects the red bar is higher. The last graph shows the production gain when the KMS Ceremonies do not affect at production. This section is detailed in the KMS Ceremony section.

VI. NEW OPERAS PERSO CONFIGURATION

Now that the control operas was created, the second part needed to be analyzed, which consisted in creating a new standard operas for the personalization of the chip of the cards.

Barcelona has a history of having the oldest machines of at least 20 years old and their performance was not that great. One point analyzed was that the machines most of the time would fail at the Smartcard module, which is the module of the machine that has personalization stations where these stations make contact with the chip, and via TCP/IP connection, personalizes the chip via a specific script. When the machine would fail at that module, then all the cards inside the stations had to be replaced, and therefore the card yield loss, which defines the amount of cards spent to make one card, increased greatly. The machines also could not support too many stations in them because of their bad configured operas and the machine would freeze if four or more stations were to be installed. Usually, all of the machines had between two or three stations and that would limit the performance of the machine.

The objective of this second part was to lower the card yield loss, increase the amount of stations of the machines in installing the optimized number, and therefore increase the performance of the machines in order to be able to produce more and in consequence earn more money from customers.

Using the same code as for the control, I found out all of the operas calls the personalization script had. I downloaded the latest version of all of them and install them in the operas folder of the control. Before, the operas was split into two: one for the control and one for the personalization. I decided to group mine and to just create one so that there won't be any confusion. I then read all of the new libraries specifications and configured them correctly in the operas.ini configuration file. I compared my operas folder to the old one that was currently installed and the new standard just had 43 files instead of 125 files. I reduced it by almost three times its components and finally Barcelona had something cleaned to work with.

The last part to configure in the operas.ini file was the connection to the KMS server. After many conversations with the department that takes care of the configuration of the KMS, informed me that the KMS can accept up to ten connections at a time. I looked at the configuration of the operas.ini that was currently installed and I noticed that it was set to only one connection, as follows:

```
[KMS]
Type=FS
Host_1=IP KMS:PORT
```

I decided to change this configuration in the new operas.ini as:

```
[KMS]
Type=FS
Host_1= IP KMS:PORT
Host_2= IP KMS:PORT
Host_3= IP KMS:PORT
Host_4= IP KMS:PORT
Host_5= IP KMS:PORT
Host_6= IP KMS:PORT
Host_7= IP KMS:PORT
Host_8= IP KMS:PORT
Host_9= IP KMS:PORT
Host_10= IP KMS:PORT
```

Allowing the connection to the KMS being this way optimizes the connection to the servers for the personalization. Now, when a card would enter a station, it would not wait until the card before would have terminated its personalization to start personalizing, but all of the cards in all of the stations would personalize at the same time. This was key to the operas configuration. Now that I had the operas of the personalization created, it was time to implement it in the production floor. This was really delicate because it could affect at the daily production. After communication with the production manager, he allowed me to have one machine for five days to test the new standard operas with all of the current customers Barcelona works with. The production manager was very interested in this project because he knew that he needed to increase its production and the performance of the machines. He supported this project to the fullest and always worked around it for me to be able to do this project. In the industrialization world, it is hard to have machines available and production always has unexpected situations which generally affect the timing of the projects. Therefore, having the support of the production manager was very helpful in finishing this project on time.

Now that I had one machine available for a week, I had to organize myself with production and Data Processing in order to be able to produce one card for each client and run the control of the chip with the new standard operas. Production needed to provide me with the physical cards of each client and Data Processing (DP) had to reprocess input files for every client. This process was not easy and is normally forgiven for security purposes. I had to get permission from security to be able to reproduce one card of real production files, and I also had to get permission from Customer Service (CS) to be able to take out cards from the Vault for each client.

It took a couple weeks for me to be provided with all the necessary and to have the machine available. During my tests, I decided to make some connection performance with the old operas and the new standard operas to see if it really had an impact. When the machine personalizes a card, a window pops up and actually shows the personalization time for that card. I used this information by having the most accurate data. The tables below show the results of the personalization time for the clients I was studying.

BEFORE		AFTER	
CLIENTS	TOTAL PERSONALIZATION TIME / CARD (mins)	CLIENTS	TOTAL PERSONALIZATION TIME /CARD(mins)
LA CAIXA EMV	0.18	LA CAIXA EMV	0.13
BBVA EMV	0.20	BBVA EMV	0.15
AVERAGE PERSONALIZATION TIME FOR ALL CLIENTS EMV (mins)	**0.19**	**AVERAGE PERSONALIZATION TIME FOR ALL CLIENTS EMV (mins)**	**0.14**

Table 11. EMV Personalization Time

BEFORE		AFTER	
CLIENTS	TOTAL PERSONALIZATION TIME / CARD (mins)	CLIENTS	TOTAL PERSONALIZATION TIME / CARD (mins)
LA CAIXA CLESS	0.22	LA CAIXA CLESS	0.16
BBVA CLESS	0.33	BBVA CLESS	0.25
SANTANDER UNIVERSITIES	0.58	SANTANDER UNIVERSITIES	0.55
AVERAGE PERSONALIZATION TIME FOR ALL CLIENTES EMV (mins)	**0.38**	**AVERAGE PERSONALIZATION TIME FOR ALL CLIENTES EMV (mins)**	**0.32**

Table 12. Contactless Personalization Time

The tables above show that the new standard operas greatly affected the personalization times of the card. It does not seem that big of a change, but this time is per card. In an industrialization environment, not just one card is done, but more than 300 000+ a month, and this small change is then seen. For the EMV cards, the average personalization times went from 0.19 seconds to 0.14 seconds. That is a difference of 0.05 seconds per card, so the machine will perform at a higher rate. This can be interpreted as that the machine will be able to produce the same amount of cards in a quicker time, or to produce more in the same time frame. For the Contactless cards, the personalization time improved from 0.38 seconds to 0.32 seconds. The personalization time is doubled because the personalization scripts of the contactless cards are much longer.

The graphs below clearly show that the personalization time decreased with the new standard operas.

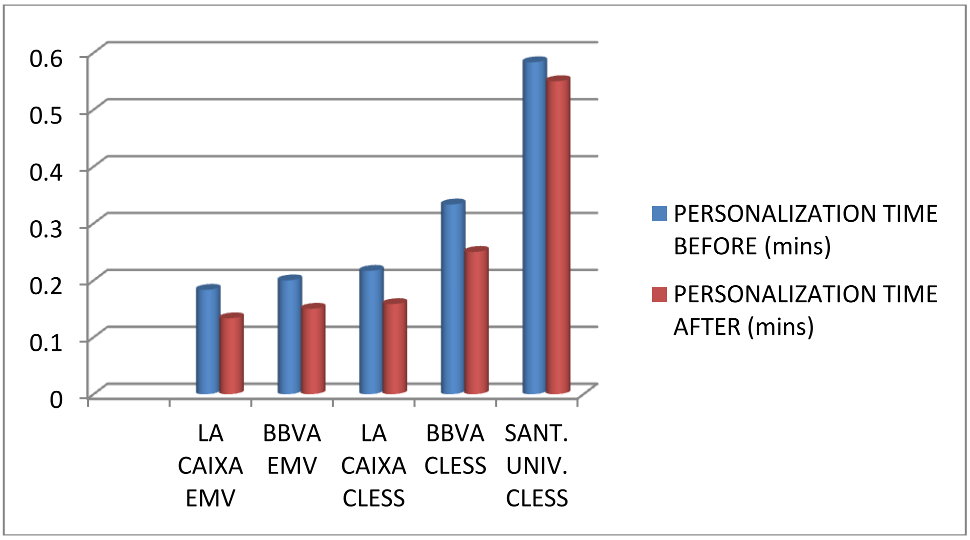

Figure 8. Total Personalization Time Savings Per Client

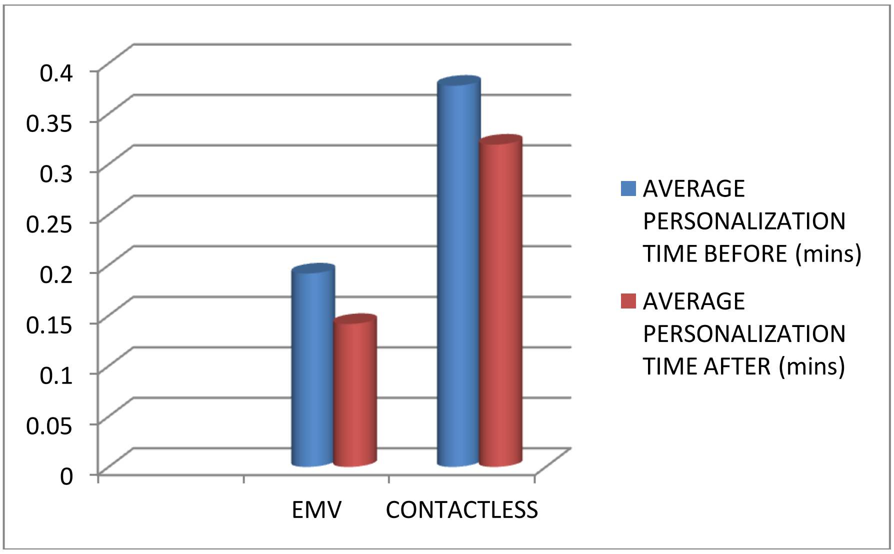

Figure 9. Average Personalization Saving Time Per Type

The tests of all clients succeeded and all types of cards were validated, except one, which was one Contactless card. It was giving an error during the personalization of the chip. I analyzed the error, and I found out that the error was coming from an operas service called “PERSO”. During personalization, this library connects with the platform (which I will explain later), and automatically changes a value set as “FFFF” to the customer code, which normally is the code of the site where the card is made, in this case Barcelona, which has the code “0113”.

This automatic conversion was not being made because the platform that was installed was an older version (version 6.9.0) and did not support the latest version of the “PERSO.dll”. I reported this issue, and they advised me to migrate to the newer version of the platform version 6.9.13. This change request was not easy to do, but had a huge impact on my project. Without this migration, my project will not be working.

VII. PLATFORM MIGRATION

As explained above, a platform migration was needed for the Barcelona production shop floor for this project to be implemented. This would delay the project a long time but there was no other choice.

A. PLATFORM DEFINITION

I got in contact with the PSE department, who take care of the deployment of the platforms in order to provide me with the documentation and to understand what the platform is and how to deploy it.

After reading a lot of documentation, I realized that the platform is basically a tool that makes the machine create a job in order to produce the cards. The platform will assemble all of the different parts, such as a production file and a script, and will also configure the stations, with the aid of a SPI, which is an encryption tool. The platform is composed of four mandatory files:

- An executable Platform.exe
- |An interface library for Supervisors SlbPlatform.dll
- A configuration file Platform.ini
- Supervisor INI file SlbPlatform.ini

Migrating to the new version will mean that all of these files will also have to be created from scratch and to be configured correctly. I knew that this migration was needed because it will also help the production because this platform had its particularities of being faster and more reliable at the configuration times.

B. MIGRATION

Getting in contact with the platform department, they informed me that in order to have this platform implemented, Barcelona needs to make sure that all of its production files have the encryption keys implemented in the header of the file and not in a separate file. I knew that the production files for “La Caixa” were using a separate file (with an .app extension) where the keys were stated. I, therefore, contacted with the Technical Consultant (TC) and informed her that a change request was needed to be addressed to the Order Engineering team (OE).

When an input file from a client is received, it is processed by a specific configuration developed by OE in an internal software (the name cannot be said for security reasons) to produce the production file, and the encryption keys are sent by OE in a separate file. Now, the OE team had to develop another configuration that will replace the old one, and therefore affect the entire production for “La Caixa” so that at the DP time, the production file would have the encryption keys in the header.

The OE team gave us feedback and told us that this delivery could not be made until three weeks. I could not migrate to the new platform and could not implement the new standard operas until the new delivery from OE would arrive and all the tests for all clients were again made with the new platform, so it was waiting time.

During this time, I was preparing myself to install the new platform, and I had to download the new Platform.exe, the new SlbPlatform.dll, but I had to configure the platform.ini and the SlbPlatform.ini. The SlbPlatform.ini was easy to configure because it is the same file for all machines. The platform.ini is different because the personalization stations need to be defined there. Each machine has different type of stations and different number, so it was complicated to configure this file. I investigated each machine, found out what type of stations were in each, how many, and the IP addresses of the stations. There are two types of stations used in Barcelona: STAR 260/265 and MP300. Each of them has a different configuration in the platform.ini file because their IP configuration is different. For the STAR 260/265, each station installed has its own IP address, but the MP300, all of the stations installed have the same IP address. Below is an example of how the [TESTER] section of the platform.ini needs to be configured.

STAR260/265

[TESTER_1]
Type=STAR
Address=199.1.1.81

[TESTER_2]
Type=STAR
Address=199.1.1.82

[TESTER_3]
Type=STAR
Address=199.1.1.83

[TESTER_4]
Type=STAR
Address=199.1.1.84

[TESTER_5]
Type=STAR
Address=199.1.1.85

[TESTER_6]
Type=STAR
Address=199.1.1.86

[TESTER_7]
Type=STAR
Address=199.1.1.87

MP300

[TESTER_1]
Type=MP300
Address=199.1.1.82
ContactHead=0
Serial=COM11 9600,n,8,1

[TESTER_2]
Type=MP300
Address=199.1.1.82
ContactHead=0
Serial=COM11 9600,n,8,1

[TESTER_3]
Type=MP300
Address=199.1.1.82
ContactHead=1
Serial=COM12 9600,n,8,1

[TESTER_4]
Type=MP300
Address=199.1.1.82
ContactHead=2
Serial=COM13 9600,n,8,1

[TESTER_5]
Type=MP300
Address=199.1.1.82
ContactHead=3
Serial=COM14 9600,n,8,1

Each machine can accept up to seven personalization stations. The platform.ini configuration file has other sections defined below. An example of an entire platform.ini file cannot be shown for security reasons.

- GENERAL: Where the path of the personalization script is defined, the path of the platform, the path of the SPI, and audit paths.
- OPERAS: defines the path where the operas executable is located
- SECURITY: defines the customer code, and secured parameters to specify that the cards have been produced by Barcelona Site
- TRACE: to enable a trace for debug
- WORKESTRA: defines the production server in order for the platform to load the jobs into the machine

This platform.ini file needs to be correctly configured for the machine to work correctly. The new configuration arrived and it was time to test it on one machine. Before hands, I had talked to the production manager and he allowed me one machine for three days to do all the testing.

VIII. TESTING

During the waiting period, I had prepared the platform configuration, the production files of all clients, and the cards I will use. DP reprocessed with the new configuration all of the files I told them to. I checked how the production files were created and indeed, the encryption keys were now in the header. This was good news because this new configuration was correct and no regression was needed.

The tests for all customers went perfect and all of the cards were good. This was a relief because this proved that the new standard operas, the optimized configuration of the platform along with the new configuration all worked together smoothly. Now, I needed to take indicators for the clients I was analyzing (La Caixa, BBVA, and Santander Universities).

A. THEORETICAL

The machine I was using for my tests had three personalization stations installed. This is very important to know because it is directly related to the performance of the machine, even though other modules of the machines could have some limitations. A module is a part of the machine that is dedicated to specific work. This machine had seven modules:

- Magnetic stripe encoder: writes data into the magnetic stripe
- Smart Card: personalizes the chip (location of the personalization stations)
- Front Ultragrafix: used for thermal printing
- Full Card Overlay: used to place a protection (only for Santander Universities)
- Front Embosser: used to stamp the front of the card, usually the name, PAN, expiration date

- Front/Back Embosser: used to stamp the CVV2
- Topper: places the color for which the characters need to appear (silver, gold, black, white)
- Ultralabel: used to stick the activation label on the card

For the calculations and indicators, I did not take into account the ultralabel module because this module was not used during the tests and I considered the two embossers plus the topper modules as one module. In order to make an accurate analysis, I decided to first compare the theoretical versus the practical, with both the old and the new configuration.

Upon my request, the maintenance department provided me with the documentation of the machine to find the theoretical performance of each module. Then, I got in contact with the company that makes the machine and they sent me some very interesting documentation that shows the relationship between the number of personalization stations installed and the rate at which the cards are processed in the smart card module per hour. The picture below shows this proportionality.

NUMBER OF 9000 SYSTEM Gen 3 SMART CARD STATIONS
REQUIRED FOR GIVEN THROUGHPUT & PROGRAMMING TIME

1200	3	5	6															
1100	3	4	6	7														
1000	3	4	5	7														
900	2	4	5	6	7													
800	2	3	4	5	7													
700	2	3	4	5	6	7												
600	2	3	3	4	5	6	7											
500	2	2	3	4	4	5	6	6	7									
400	1	2	2	3	4	4	5	5	6	6	7	7						
300	1	2	2	2	3	3	4	4	4	5	5	6	6	7	7	7		
200	1	1	1	2	2	2	3	3	3	3	4	4	4	5	5	5	5	6
100	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90

PROGRAMMING TIME (Sec)

Table 13. Personalization Time vs Number of Cards per Hour

These calculations are based on the stock machines when it comes out of the factory. In Barcelona, the machines have been tuned up a little and the values are not exact, but it greatly approximates the theoretical value and is sufficient to be a comparison for this project.

An interesting graph I had seen in the documentation was the relationship between the embosser module and the number of cards per hour processed. The table below shows that the more embossers the machine has, the faster it stamps because it divides the number of characters to stamp in each embosser.

Each line is 21 characters long.

Number of Embossers	Card per Hour
1	387
2	616
3	650
4	1055

Table 14. Number of Embossers vs. Cards per Hour

As the table shows above, the number of characters to stamp on the card plays a major role in the performance of this module. The machine I was using had two embossers, therefore, theoretically, was only able to produce 616 cards per hour. The optimum is to use four embossers because that almost doubles the performance, but none of the machines have this type of configuration. The graph below shows the relationship between characters to stamp versus the number of cards per hour it can produce.

500 CPH Embosser/Topper Module Combination

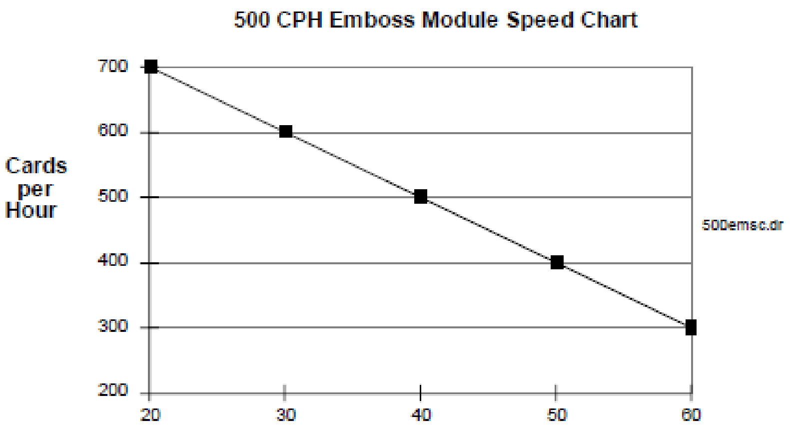

Figure 10. Number of Characters to Stamp vs. Cards per Hour

The graph above demonstrates the proportionality between having two embossers and the number of characters to stamp. Usually, credit cards have 42 characters to stamp on the front, therefore the two embossers will stamp each 21 characters, and this is where this number comes from. The breakdown is:

- PAN: 16 characters
- Expiration date: 5 characters
- Cardholder name: Max 21 characters

With the help of this information, I was able to create a table that would show the performance per personalization stations installed of each module of each type of card for each client. Using the personalization time I had found in the previous steps, the following theoretical table was created.

THEORETICAL ALL CLIENTS							
MODULE	1 CHIP STATIONS	2 CHIP STATIONS	3 CHIP STATIONS	4 CHIP STATIONS	5 CHIP STATIONS	6 CHIP STATIONS	7 CHIP STATIONS
Mag Stripe La Caixa EMV	700	800	900	950	1050	1150	1250
Mag Stripe La Caixa CLESS	400	500	600	700	800	900	1000
Mag Stripe BBVA EMV	700	800	900	950	1050	1150	1250
Mag Stripe BBVA CLESS	400	500	600	700	800	900	1000
Mag Stripe SANT UNIV	400	500	600	700	800	900	1000
Smart Card La Caixa EMV	200	500	800	1100	1200	1200	1200
Smart Card La Caixa CLESS	200	400	600	800	1000	1200	1200
Smart Card BBVA EMV	200	400	625	800	950	1150	1200
Smart Card BBVA CLESS	100	300	500	600	800	900	1100
Smart Card SANT. UNIV.	100	200	300	500	600	700	900
Ultragrafix module SANT UNIV	800	800	800	800	800	800	800
Full Card Overlay SANT UNIV	500	600	675	700	725	750	750
Embosser + Topper All Clients (2 Embs)	616	616	616	616	616	616	616
Embosser + Topper All Clients (4 Embs)	1055	1055	1055	1055	1055	1055	1055

Table 15. Theoretical Performance For All Clients

As one can notice in the table above, that some modules, like the embosser plus topper combination, have limitations and based on the theoretical will always be 616 cards per hour, and there is nothing we can do to improve that, therefore the total throughput of the machine will always be the throughput of the slower module.

With the old configuration, the machines could not go over three personalization stations because with the previously bad operas configuration, the servers would get overloaded and the machine would freeze. Because the other modules could not be improved, the objective of this project was to find the optimum number of personalization stations to install on each machine in order to maximize the performance of the smart card module.

I concentrated my project on greatly improving the smart card module. Based on the table above, I made an extraction of the smart card module values for all clients (lines 6-10 in the table). The table below shows this extraction.

THEORETICAL ALL CLIENTS					
NUMBER OF STATIONS INSTALLED	MAX SMART CARD LA CAIXA EMV(cards/hour)	MAX SMART CARD LA CAIXA CLESS (cards/hour)	MAX SMART CARD BBVA EMV (cards/hour)	MAX SMART CARD BBVA CLESS(cards/hour)	MAX SMART CARD SANT. UNIV.(cards/hour)
1	200	200	200	100	100
2	500	400	400	300	200
3	800	600	625	500	300
4	1100	800	800	600	500
5	1200	1000	950	800	600
6	1200	1200	1150	900	700
7	1200	1200	1200	1100	900

Table 16. Smart Card Module theoretical Values For All Clients

With this extraction, I could easily see that if the machine has more than five personalization stations installed, then the performance of the smart card module does not increase at all, therefore I knew that the optimization could be around five stations per machine, but again this was theoretical. A graph would help me see this better.

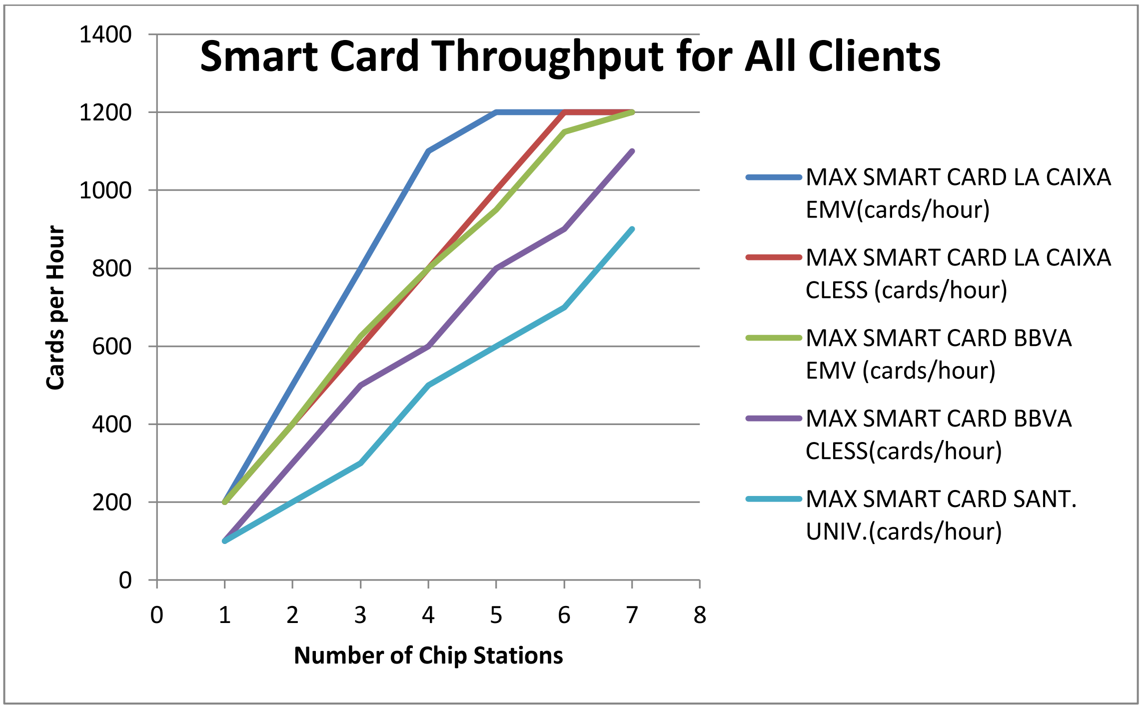

Figure 11. Smart Card Throughput For All Clients

This graph is just a graph of Table 3, but now I could see that the optimization number of stations could vary between clients. This was due to the personalization time of the type of cards used. The contactless cards, which have a longer personalization time, need seven stations installed to be fully maximized, whereas the EMV cards just need between five or six. This is logic because the higher is the time a card spends in a station, the longer is the waiting time for the next card to enter, therefore the more stations the machine has, the less is the waiting time, and the machine is always flowing.

As mentioned before, the total throughput of the machine is the lowest module throughput (the module that produces the least number of cards per hour) and this gives limitation to the performance of the entire machine, as shown in the table below.

THEORETICAL ALL CLIENTS (2 EMBOSSERS)					
NUMBER OF STATIONS INSTALLED	TOTAL THROUGHPUT LA CAIXA EMV(cards/hour)	TOTAL THROUGHPUT LA CAIXA CLESS (cards/hour)	TOTAL THROUGHPUT BBVA EMV (cards/hour)	TOTAL THROUGHPUT BBVA CLESS(cards/hour)	TOTAL THROUGHPUT SANT. UNIV.(cards/hour)
1	200	200	200	100	100
2	500	400	400	300	200
3	616	600	625	500	300
4	616	616	616	600	500
5	616	616	616	616	600
6	616	616	616	616	700
7	616	616	616	616	750

Table 17. Total Machine Throughput

The table clearly shows that the machine is limited to the embosser module. The graph below represents Table 4.

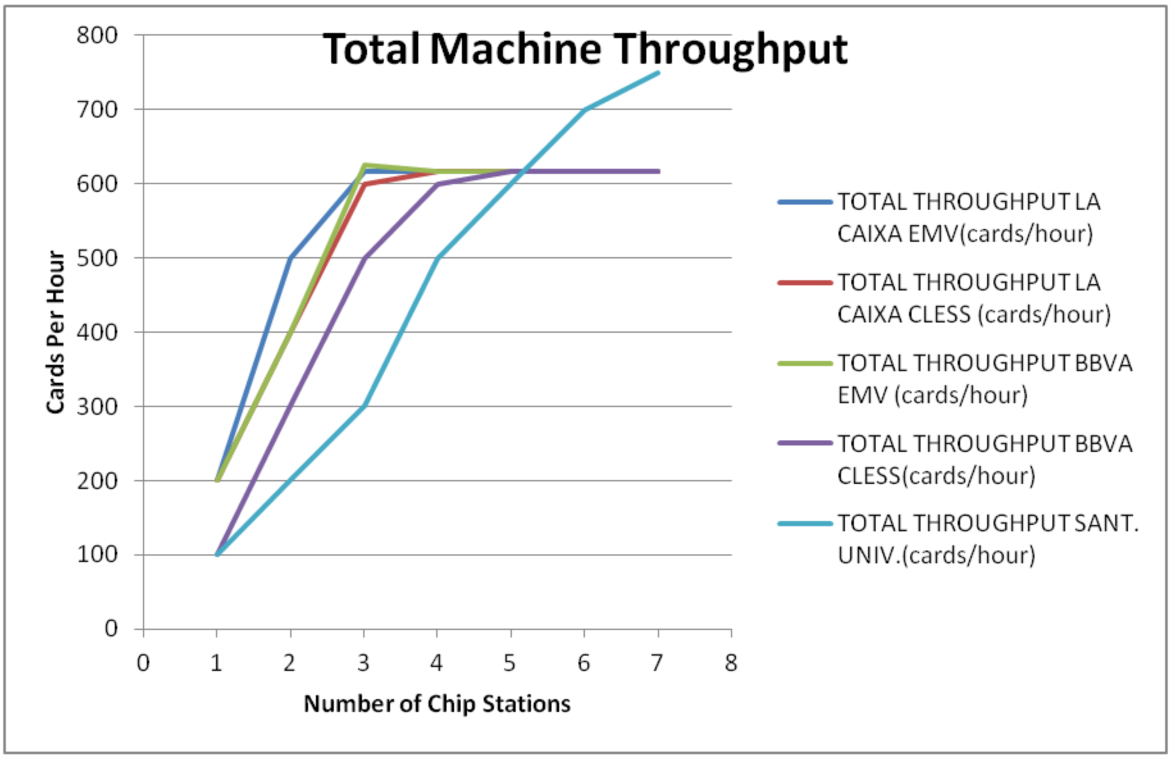

Figure 12. Total Machine Throughput

All of the clients stop at 616 cards per hour because they all use the embosser module, except Santander Universities that uses the Ultragrafix module, which prints the characters much faster, and this is why the total machine throughput for this client is higher. Only the clients with long personalization time will have a slightly better throughput rate and a better result.

B. PRACTICAL WITH OLD CONFIGURATION

The first step on the practical analysis was to run indicators on the performance of the machine on these three clients with the configuration Barcelona had been using until now. I was able to come up with very accurate values because I used the information given by the report files generated by the machine after a production has been done. This helped me in looking at time frames and in knowing how long it took to make one card. The analysis was broken down into the behavior of each module of the machine. The indicators can be found in the table below.

LA CAIXA EMV							
MACHINE NUMBER	NUMBER OF STATIONS INSTALLED	MAX MAG STRIPE (cards/hour)	MAX SMART CARD (cards/hour)	MAX ULTRAGRAFIX (cards/hour)	Full Card Overlay SANT UNIV	MAX EMBOSSER + TOPPER (cards/hour)	TOTAL THROUGHPUT OF THE MACHINE (cards/hour)
DC22	3	864	600	NOT APPLICABLE	NOT APPLICABLE	655	600
LA CAIXA CONTACTLESS							
MACHINE NUMBER	NUMBER OF STATIONS INSTALLED	MAX MAG STRIPE (cards/hour)	MAX SMART CARD (cards/hour)	MAX ULTRAGRAFIX (cards/hour)	Full Card Overlay SANT UNIV	MAX EMBOSSER + TOPPER (cards/hour)	TOTAL THROUGHPUT OF THE MACHINE (cards/hour)
DC22	3	720	617	NOT APPLICABLE	NOT APPLICABLE	697	617
BBVA EMV							
MACHINE NUMBER	NUMBER OF STATIONS INSTALLED	MAX MAG STRIPE (cards/hour)	MAX SMART CARD (cards/hour)	MAX ULTRAGRAFIX (cards/hour)	Full Card Overlay SANT UNIV	MAX EMBOSSER + TOPPER (cards/hour)	TOTAL THROUGHPUT OF THE MACHINE (cards/hour)
DC22	3	864	675	NOT APPLICABLE	NOT APPLICABLE	697	675
BBVA CONTACTLESS							
MACHINE NUMBER	NUMBER OF STATIONS INSTALLED	MAX MAG STRIPE (cards/hour)	MAX SMART CARD (cards/hour)	MAX ULTRAGRAFIX (cards/hour)	Full Card Overlay SANT UNIV	MAX EMBOSSER + TOPPER (cards/hour)	TOTAL THROUGHPUT OF THE MACHINE (cards/hour)
DC22	3	584	480	NOT APPLICABLE	NOT APPLICABLE	540	480
SANTANDER UNIVERSITIES							
MACHINE NUMBER	NUMBER OF STATIONS INSTALLED	MAX MAG STRIPE (cards/hour)	MAX SMART CARD (cards/hour)	MAX ULTRAGRAFIX (cards/hour)	Full Card Overlay SANT UNIV	MAX EMBOSSER + TOPPER (cards/hour)	TOTAL THROUGHPUT OF THE MACHINE (cards/hour)
DC15	3	470	270	460	386	NOT APPLICABLE	270

Table 18. Practical Performance With Old Configuration

The first column shows the machine number. I used the same machine for all clients, except Santander Universities because of the Full Card Overlay module. The second column defines the number of stations installed on the machine. As we mentioned before, three stations were installed on all machines because more was not possible. Each column after that defines the modules of the machine and whether or not it is applicable. The last column shows the total throughput of the machine for that specific client and type of card based on the information given in the columns before that, and the total machine throughput is equal to the lowest module throughput.

The contactless cards with the long personalization time have the worst machine performance. This proves what we had seen earlier on the theoretical part. With only three stations installed, the smart card module only processes 270 cards per hour when the personalization time is higher than 25 seconds.

I decided to summarize the table above into another table to better see the numbers. I took off the constants, like the number of stations and the machine used, and rearranged it per client and type of card. The result is shown below.

PRACTICAL				
MAG STRIPE MODULE THROUGHPUT				
LA CAIXA EMV	LA CAIXA CLESS	BBVA EMV	BBVA CLESS	SANTANDER UNIVERSITIES
864	720	864	584	470
SMART CARD MODULE THROUGHPUT				
LA CAIXA EMV	LA CAIXA CLESS	BBVA EMV	BBVA CLESS	SANTANDER UNIVERSITIES
600	617	675	480	270
ULTRAGRAFIX MODULE THROUGHPUT				
LA CAIXA EMV	LA CAIXA CLESS	BBVA EMV	BBVA CLESS	SANTANDER UNIVERSITIES
NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	460
FULL CARD OVERLAY MODULE THROUGHPUT				
LA CAIXA EMV	LA CAIXA CLESS	BBVA EMV	BBVA CLESS	SANTANDER UNIVERSITIES
NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	386
EMBOSSER MODULE THROUGHPUT				
LA CAIXA EMV	LA CAIXA CLESS	BBVA EMV	BBVA CLESS	SANTANDER UNIVERSITIES
655	697	697	540	NOT APPLICABLE
TOTAL MACHINE THROUGHPUT				
LA CAIXA EMV	LA CAIXA CLESS	BBVA EMV	BBVA CLESS	SANTANDER UNIVERSITIES
600	617	675	480	270

Table 19. Practical Old Performance Summary

The gray lines represent the modules of the machine, and by looking at the smart card module, one can know that BBVA EMV has the fastest personalization time and that Santander Universities the slowest. This is because the personalization script for BBVA EMV is much shorter and also the chip on BBVA's cards are more recent with a better technology and are able to process faster. All of these modules are constants and cannot be improved by this project, but these modules are not totally optimized yet. Improving the smart card module will also improve the other modules until reaching their optimum speed. The blue line at the bottom of the table shows the total machine throughput and the goal of this project is to increase these values, especially for Santander universities.

C. THEORETICAL VERSUS PRACTICAL OLD

I had finished the practical part and I had all of the indicators I needed to make a comparison with the theoretical. The theoretical is supposed to always be higher than the practical, but as mentioned before, the machines in Barcelona are a little tuned up and sometimes the practical was higher. This was not a major issue because the main objective of this project was that the performance of the practical with the new configuration be higher than the performance of the practical with old configuration.

I took the information of the theoretical with three stations and created a table to compare both. The table is shown below.

THEORETICAL VS PRACTICAL OLD 3 CHIP STATIONS									
MAG STRIPE MODULE THROUGHPUT									
LA CAIXA EMV		LA CAIXA CLESS		BBVA EMV		BBVA CLESS		SANTANDER UNIVERSITIES	
THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL
900	864	600	720	900	864	600	584	500	470
SMART CARD MODULE THROUGHPUT									
LA CAIXA EMV		LA CAIXA CLESS		BBVA EMV		BBVA CLESS		SANTANDER UNIVERSITIES	
THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL
600	600	500	617	500	675	300	480	300	270
ULTRAGRAFIX MODULE THROUGHPUT									
LA CAIXA EMV		LA CAIXA CLESS		BBVA EMV		BBVA CLESS		SANTANDER UNIVERSITIES	
THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL
NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	800	460
FULL CARD OVERLAY MODULE THROUGHPUT									
LA CAIXA EMV		LA CAIXA CLESS		BBVA EMV		BBVA CLESS		SANTANDER UNIVERSITIES	
THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL
NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	675	386
EMBOSSER MODULE THROUGHPUT									
LA CAIXA EMV		LA CAIXA CLESS		BBVA EMV		BBVA CLESS		SANTANDER UNIVERSITIES	
THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL
616	655	616	697	616	697	616	540	NOT APPLICABLE	NOT APPLICABLE
TOTAL MACHINE THROUGHPUT									
LA CAIXA EMV		LA CAIXA CLESS		BBVA EMV		BBVA CLESS		SANTANDER UNIVERSITIES	
THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL	THEORETICAL	PRACTICAL
616	600	500	617	500	675	300	480	300	270

Table 20. Theoretical vs. Practical Old

I have always thought that a picture is worse a thousand words, therefore I created multiple graphs to compare each module.

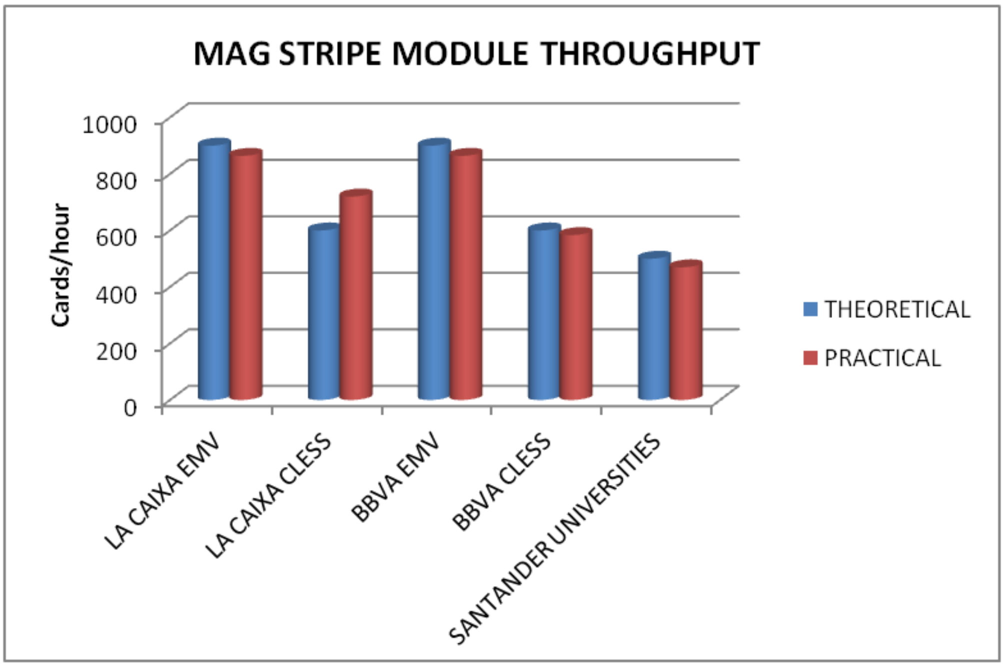

Figure 13. Magnetic Stripe Module

The Figure XX shows that the practical magnetic stripe is very close to the theoretical and for La Caixa Contactless, it is even higher.

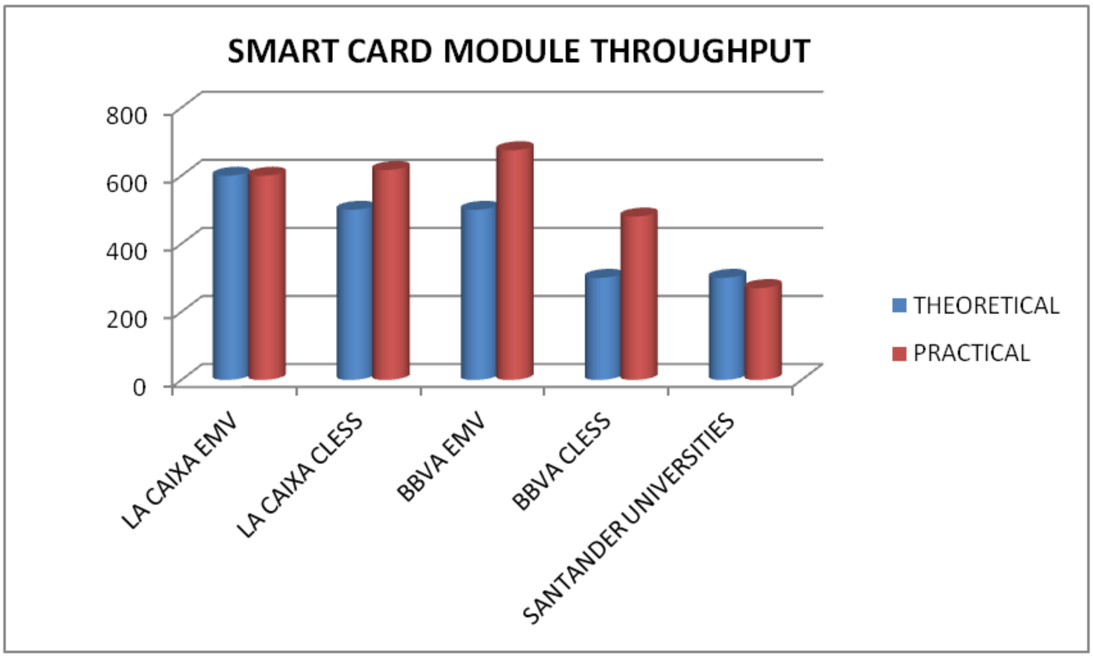

Figure 14. Smart card Module

The smart card module, the most important module in this project, has a practical much higher for La Caixa Contactless, BBVA EMV, and BBVA Contactless. The other two have about the same theoretical and practical. The point was to see if with the new configuration, these values increase.

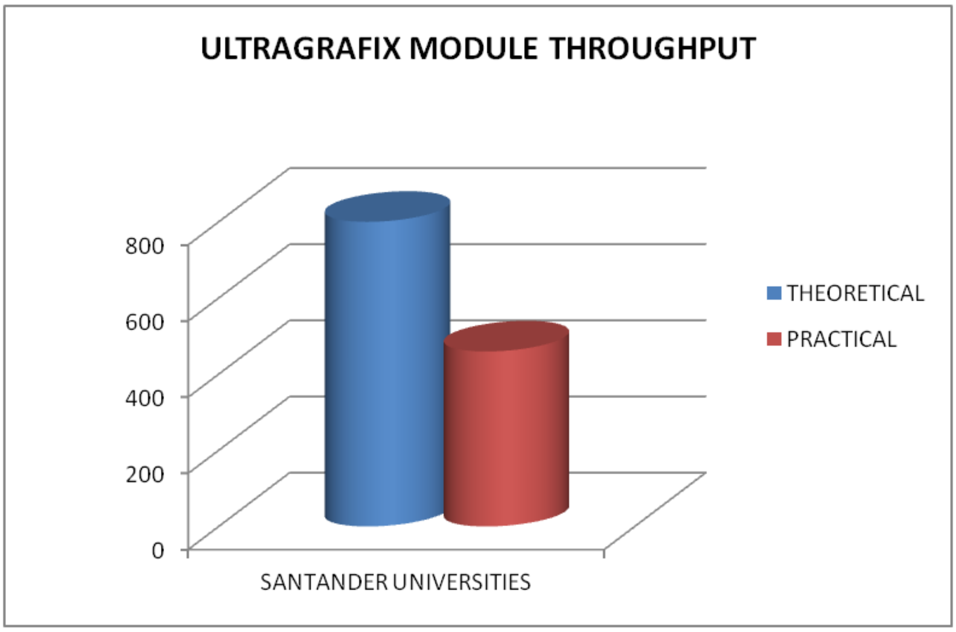

Figure 15. Ultragrafix Module

The Ultragrafix module is only used by Santander Universities and is much lower than the theoretical because of the lack of stations installed in the machine, therefore the module is always waiting on a card.

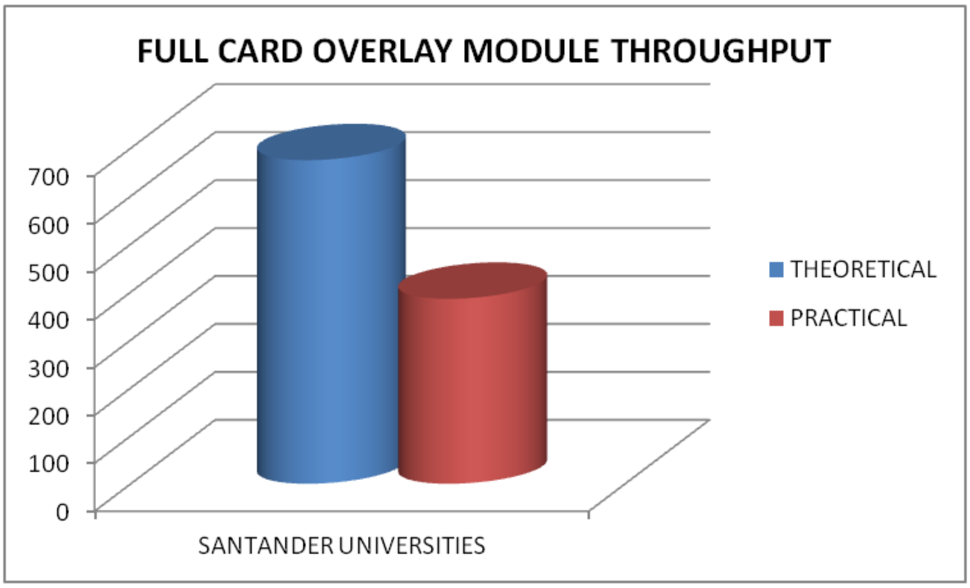

Figure 16. FCO Module

This module applies the same logic as the Ultragrafix module. The practical is much lower than the theoretical.

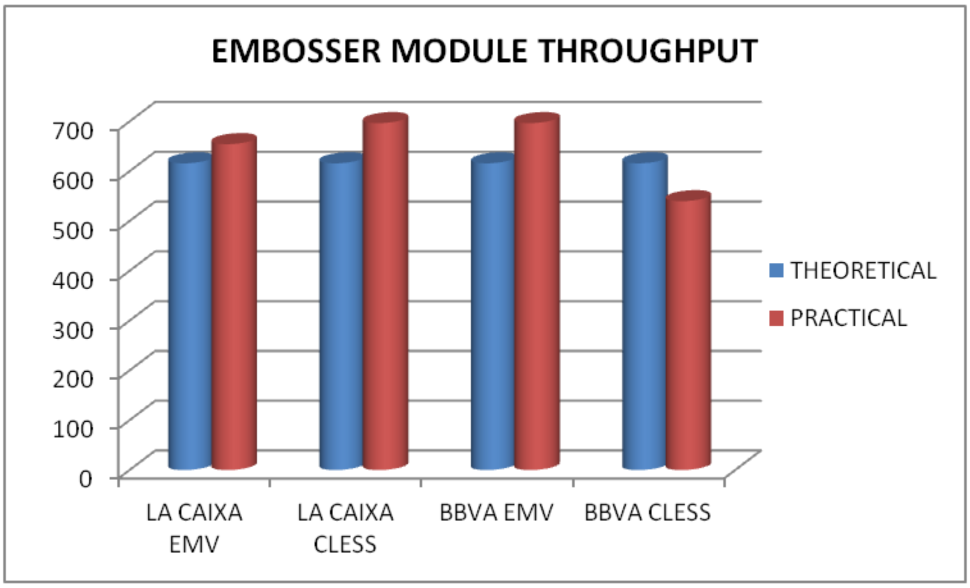

Figure 17. Embosser Module

We notice that the only client to have a lower throughput in this module is BBVA Contactless and this is due to the fact that the personalization time is higher and a lack of stations installed, therefore the module is waiting and is not at its optimum.

The last graph shows the practical total machine throughput. The production performance needs to be improved because if a customer wants to increase its volumes, then Barcelona will not be able to absorb it.

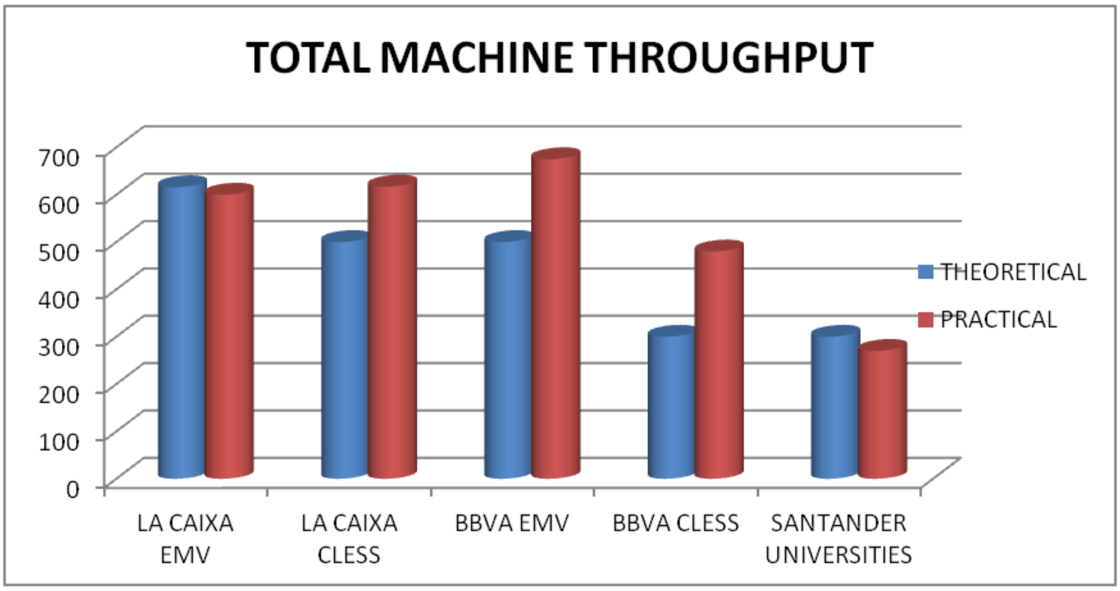

Figure 18. Total Machine Throughput

D. PRACTICAL WITH NEW CONFIGURATION

When the tests with the old configuration were finished, I erased the machine entirely and I installed what I had prepared, both the new standard operas and the new platform 6.9.13 with its configuration. I also double clicked on the CAPK.reg file that I had created to update the registry with the new public key certificates. I used the same machines to make sure that the indicators were on the same environment.

With the new machine configuration, I was able to install more personalization stations without the machine to freeze. This was a great success and it meant that the performance of the smart card module would be increased significantly. For the tests, I started with three stations and went up to seven stations, which is the maximum a machine can have installed. I did this process for every client and type of card. This was a very long process and every detailed needed to be reviewed to ensure the cards were personalized correctly. Any mistake in the configuration not controlled by me could jeopardize the company’s production, its customers, and its future. This project was never done because it was too risky for other employees to get involved in such a change. I had to coordinate myself with the maintenance team in order for them to install a new station every time I needed one.

The indicators obtained can be seen in the table below. As one can see, the number of stations is incremented by one until it reaches seven.

LA CAIXA EMV							
MACHINE NUMBER	NUMBER OF STATIONS INSTALLED	MAX MAG STRIPE (cards/hour)	MAX SMART CARD (cards/hour)	MAX ULTRAGRAFIX (cards/hour)	Full Card Overlay SANT UNIV	MAX EMBOSSER + TOPPER (cards/hour)	TOTAL THROUGHPUT OF THE MACHINE (cards/hour)
DC22	3	900	771	NOT APPLICABLE	NOT APPLICABLE	720	720
	4	939	800	NOT APPLICABLE	NOT APPLICABLE	771	771
	5	1029	939	NOT APPLICABLE	NOT APPLICABLE	800	800
	6	1200	1080	NOT APPLICABLE	NOT APPLICABLE	831	831
	7	1200	1080	NOT APPLICABLE	NOT APPLICABLE	831	831

LA CAIXA CONTACTLESS							
MACHINE NUMBER	NUMBER OF STATIONS INSTALLED	MAX MAG STRIPE (cards/hour)	MAX SMART CARD (cards/hour)	MAX ULTRAGRAFIX (cards/hour)	Full Card Overlay SANT UNIV	MAX EMBOSSER + TOPPER (cards/hour)	TOTAL THROUGHPUT OF THE MACHINE (cards/hour)
DC22	3	864	720	NOT APPLICABLE	NOT APPLICABLE	720	720
	4	900	771	NOT APPLICABLE	NOT APPLICABLE	771	771
	5	982	864	NOT APPLICABLE	NOT APPLICABLE	800	800
	6	1080	982	NOT APPLICABLE	NOT APPLICABLE	831	831
	7	1080	982	NOT APPLICABLE	NOT APPLICABLE	831	831

BBVA EMV							
MACHINE NUMBER	NUMBER OF STATIONS INSTALLED	MAX MAG STRIPE (cards/hour)	MAX SMART CARD (cards/hour)	MAX ULTRAGRAFIX (cards/hour)	Full Card Overlay SANT UNIV	MAX EMBOSSER + TOPPER (cards/hour)	TOTAL THROUGHPUT OF THE MACHINE (cards/hour)
DC22	3	900	771	NOT APPLICABLE	NOT APPLICABLE	720	720
	4	982	864	NOT APPLICABLE	NOT APPLICABLE	771	864
	5	1080	939	NOT APPLICABLE	NOT APPLICABLE	800	864
	6	1200	1080	NOT APPLICABLE	NOT APPLICABLE	831	864
	7	1200	1080	NOT APPLICABLE	NOT APPLICABLE	831	864

BBVA CONTACTLESS							
MACHINE NUMBER	NUMBER OF STATIONS INSTALLED	MAX MAG STRIPE (cards/hour)	MAX SMART CARD (cards/hour)	MAX ULTRAGRAFIX (cards/hour)	Full Card Overlay SANT UNIV	MAX EMBOSSER + TOPPER (cards/hour)	TOTAL THROUGHPUT OF THE MACHINE (cards/hour)
DC22	3	675	491	NOT APPLICABLE	NOT APPLICABLE	568	491
	4	745	540	NOT APPLICABLE	NOT APPLICABLE	617	540
	5	864	617	NOT APPLICABLE	NOT APPLICABLE	675	617
	6	1080	720	NOT APPLICABLE	NOT APPLICABLE	720	720
	7	1080	720	NOT APPLICABLE	NOT APPLICABLE	720	720

SANTANDER UNIVERSITIES							
MACHINE NUMBER	NUMBER OF STATIONS INSTALLED	MAX MAG STRIPE (cards/hour)	MAX SMART CARD (cards/hour)	MAX ULTRAGRAFIX (cards/hour)	Full Card Overlay SANT UNIV	MAX EMBOSSER + TOPPER (cards/hour)	TOTAL THROUGHPUT OF THE MACHINE (cards/hour)
DC15	3	502	277	540	441	NOT APPLICABLE	277
	4	540	309	584	480	NOT APPLICABLE	309
	5	655	480	600	502	NOT APPLICABLE	480
	6	771	540	655	540	NOT APPLICABLE	540
	7	771	540	655	540	NOT APPLICABLE	540

Table 21. Practical Performance With New Configuration

The performance of each module skyrocketed when five and six stations were installed. The total throughput of the machine doubled between three and six stations for Santander Universities and increased by an average of 200 more cards per hour for the other clients.

A table summary was also made for these indicators because I needed to find the optimum total machine throughput so that I could find out how many stations had to stay on the machine for it to be at its optimum for all clients.

PRACTICAL					
MAG STRIPE MODULE THROUGHPUT					
NUMBER OF STATIONS INSTALLED	**LA CAIXA EMV**	**LA CAIXA CLESS**	**BBVA EMV**	**BBVA CLESS**	**SANTANDER UNIVERSITIES**
3	900	864	900	675	502
4	939	900	982	745	540
5	1029	982	1080	864	655
6	1200	1080	1200	1080	771
7	1200	1080	1200	1080	771
SMART CARD MODULE THROUGHPUT					
NUMBER OF STATIONS INSTALLED	**LA CAIXA EMV**	**LA CAIXA CLESS**	**BBVA EMV**	**BBVA CLESS**	**SANTANDER UNIVERSITIES**
3	771	720	771	491	277
4	800	771	864	540	309
5	939	864	939	617	480
6	1080	982	1080	720	540
7	1080	982	1080	720	540
ULTRAGRAFIX MODULE THROUGHPUT					
NUMBER OF STATIONS INSTALLED	**LA CAIXA EMV**	**LA CAIXA CLESS**	**BBVA EMV**	**BBVA CLESS**	**SANTANDER UNIVERSITIES**
3	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	540
4	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	584
5	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	600
6	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	655
7	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	655
FULL CARD OVERLAY MODULE THROUGHPUT					
NUMBER OF STATIONS INSTALLED	**LA CAIXA EMV**	**LA CAIXA CLESS**	**BBVA EMV**	**BBVA CLESS**	**SANTANDER UNIVERSITIES**
3	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	441
4	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	480
5	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	502
6	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	540
7	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	540
EMBOSSER MODULE THROUGHPUT					
NUMBER OF STATIONS INSTALLED	**LA CAIXA EMV**	**LA CAIXA CLESS**	**BBVA EMV**	**BBVA CLESS**	**SANTANDER UNIVERSITIES**
3	720	720	720	568	NOT APPLICABLE
4	771	771	771	617	NOT APPLICABLE
5	800	800	800	675	NOT APPLICABLE
6	831	831	831	720	NOT APPLICABLE
7	831	831	831	720	NOT APPLICABLE
TOTAL MACHINE THROUGHPUT					
NUMBER OF STATIONS INSTALLED	**LA CAIXA EMV**	**LA CAIXA CLESS**	**BBVA EMV**	**BBVA CLESS**	**SANTANDER UNIVERSITIES**
3	720	720	720	491	277
4	771	771	864	540	309
5	800	800	864	617	480
6	831	831	864	720	540
7	831	831	864	720	540
OPTIMUM	**831**	**831**	**864**	**720**	**540**

Table 22. Practical New Performance Summary

In this form, the total machine throughput was easy to see and the optimum was known, being the higher throughput between all of the stations.

- LA CAIXA EMV: 831 cards per hour, 6 stations needed

- LA CAIXA CLESS: 831 cards per hour, 6 stations needed
- BBVA EMV: 864 cards per hour, 4 stations needed
- BBVA CLESS: 720 cards per hour, 6 stations needed
- SANTANDER UNIVERSITIES: 540 cards per hour, 6 stations needed

All of the clients needed six stations to be installed on the machines in order to work at their maximum performance, except BBVA EMV, where four or six stations did not change its throughput, therefore the optimum I decided to implement in the Barcelona shop floor was six stations on each machine instead of three. I doubled the number of stations, which optimized the smart card module and maximized the performance of the other modules. I took the initiative to order 15 stations to have them installed on all the machines.

E. PRACTICAL OLD VERSUS PRACTICAL NEW

The comparison between the practical old and the practical new only was done for three personalization stations installed because in the practical old, more stations could not have been used. In the comparison table below, we can notice that all of the performance of all of the modules with the new configuration increased. Some of them increased significantly, some of them not so much, but this is because for clients with long personalization times, more stations need to be installed to see a significant change.

PRACTICAL OLD VS PRACTICAL NEW		
MODULE	**PRACTICAL OLD 3 CHIP STATIONS (cards/hour)**	**PRACTICAL NEW 3 CHIP STATIONS**
Mag Stripe La Caixa EMV	864	900
Mag Stripe La Caixa CLESS	720	864
Mag Stripe BBVA EMV	864	900
Mag Stripe BBVA CLESS	584	675
Mag Stripe SANT UNIV	470	502
Smart Card La Caixa EMV	600	771
Smart Card La Caixa CLESS	617	720
Smart Card BBVA EMV	675	771
Smart Card BBVA CLESS	480	491
Smart Card SANT. UNIV.	270	277
Ultragrafix module SANT UNIV	460	540
Full Card Overlay SANT UNIV	386	441
Embosser + topper La Caixa EMV	655	720
Embosser + topper La Caixa CLESS	697	720
Embosser + topper BBVA EMV	697	720
Embosser + topper BBVA CLESS	540	568

Table 23. Practical Old vs. Practical New

The graph corresponding to the table above clearly shows that the red bar is higher for all modules. This proves that the new configuration is actually correct and responds to the expectation for the improvement of the Barcelona shop floor. If no stations would to be installed, then the performance would be as demonstrated in the graph below, but the point of the project is to find the optimum number of stations, which was defined earlier to be six. We will later look at the indicators for four stations up to seven stations, and clearly see that six is the optimum.

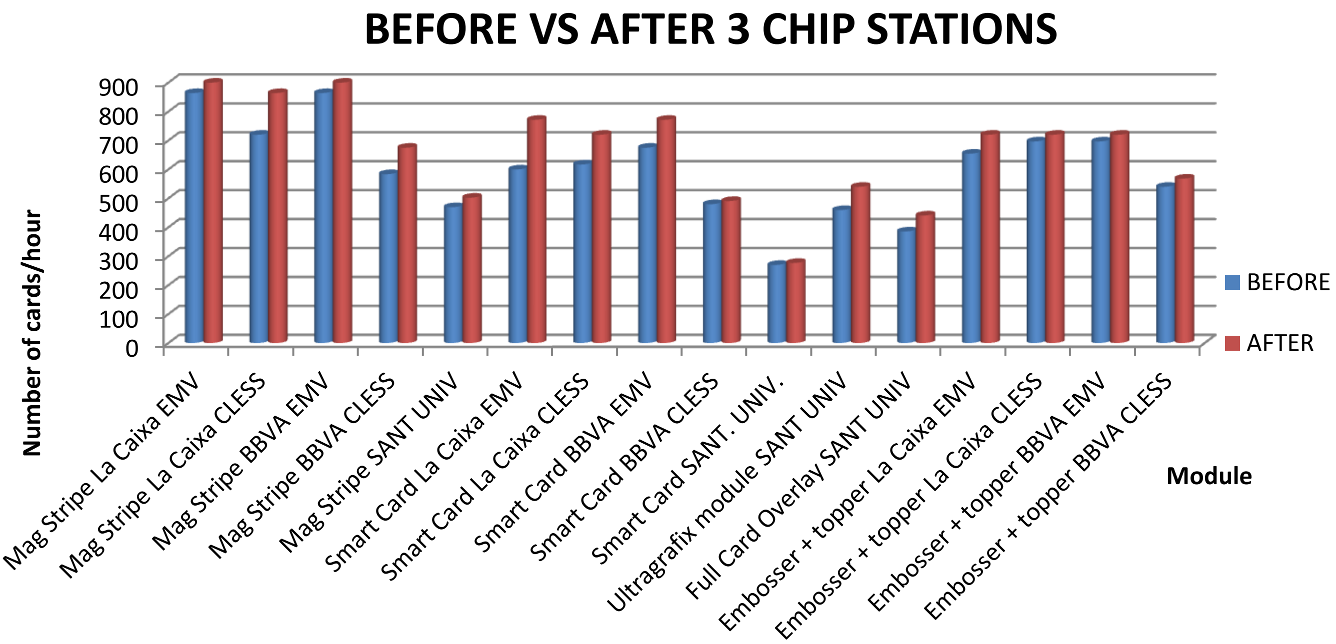

Figure 19. Practical Old vs. Practical New

F. THEORETICAL VERSUS PRACTICAL NEW

I could not compare the practical old with more stations, therefore I decided to compare the performance of the machine with the theoretical, so that I could have some sort of reference and then compare the optimum to what was installed before. With the indicators I had registered for every station, I made some comparison between the theoretical and the new configuration, based on all different modules, clients, and types of card. The two tables that demonstrate this comparison are shown below. The first table is the comparison between the theoretical and practical new for four and five stations. The second table is the comparison between the theoretical and practical new for six and seven stations

PRACTICAL NEW VS THEORETICAL				
MODULE	THEORETICAL (4 CHIP STATIONS)	PRACTICAL (4 CHIP STATIONS)	THEORETICAL (5 CHIP STATIONS)	PRACTICAL (5 CHIP STATIONS)
Mag Stripe La Caixa EMV	950	939	1050	1029
Mag Stripe La Caixa CLESS	700	900	800	982
Mag Stripe BBVA EMV	950	982	1050	1080
Mag Stripe BBVA CLESS	700	745	800	864
Mag Stripe SANT UNIV	600	540	700	655
Smart Card La Caixa EMV	700	800	900	939
Smart Card La Caixa CLESS	700	771	900	864
Smart Card BBVA EMV	700	864	900	939
Smart Card BBVA CLESS	400	540	600	617
Smart Card SANT. UNIV.	400	309	500	480
Ultragrafix (SANT UNIV)	800	584	800	600
Full Card Overlay SANT UNIV	700	480	725	502
Embosser + topper La Caixa EMV	616	771	616	800
Embosser + topper La Caixa CLESS	616	771	616	800
Embosser + topper BBVA EMV	616	771	616	800
Embosser + topper BBVA CLESS	616	617	616	675

Table 24. Practical New vs. Theoretical 4-5 Stations

The first thing we can notice is that the smart card module has greatly increased its performance and that triggered the increase of the performance of the other modules, like for example the embosser plus topper combination. If we look closer to this module, while the theoretical stayed at 616 cards per hour, the practical with four stations raised up to 771 cards per hour and with five stations to 800 cards per hour. This is a 23% increase just by adding two stations on the machine. The two graphs below show the table above, and the comparison can be easier seen.

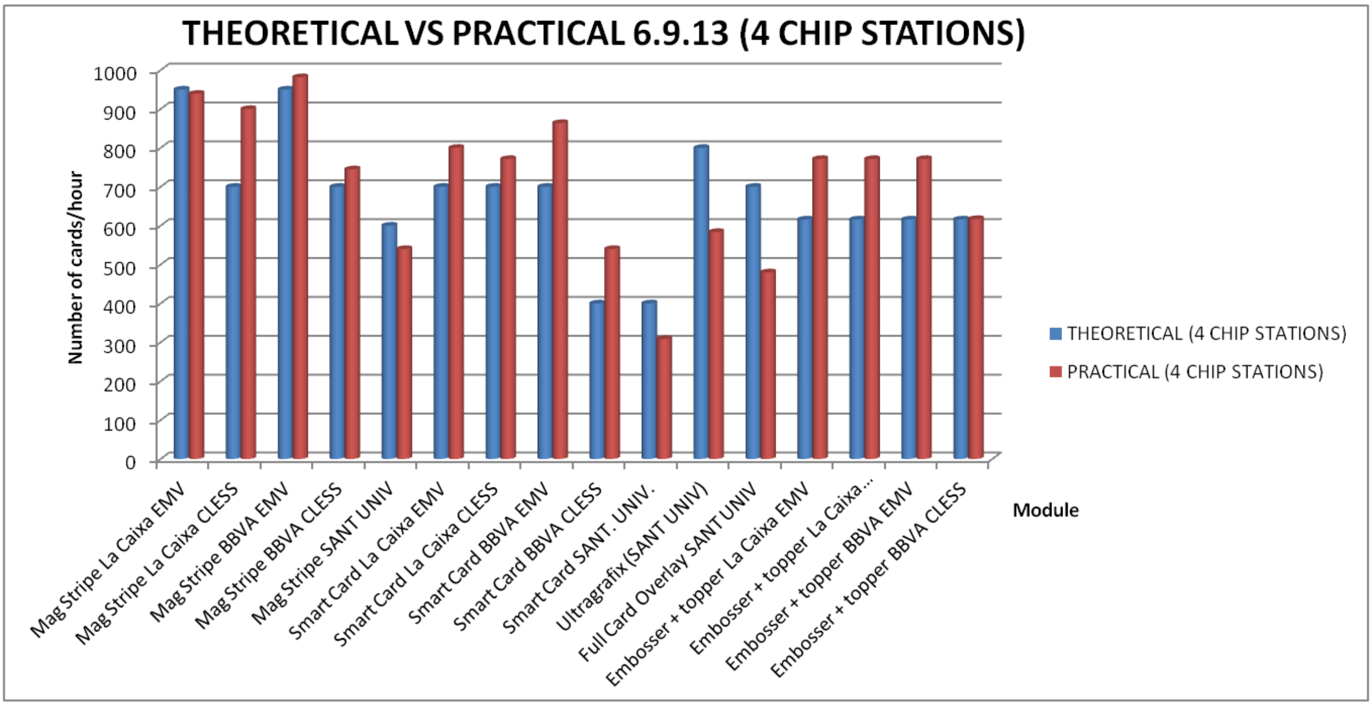

Figure 20. Practical New vs. Theoretical 4 Stations

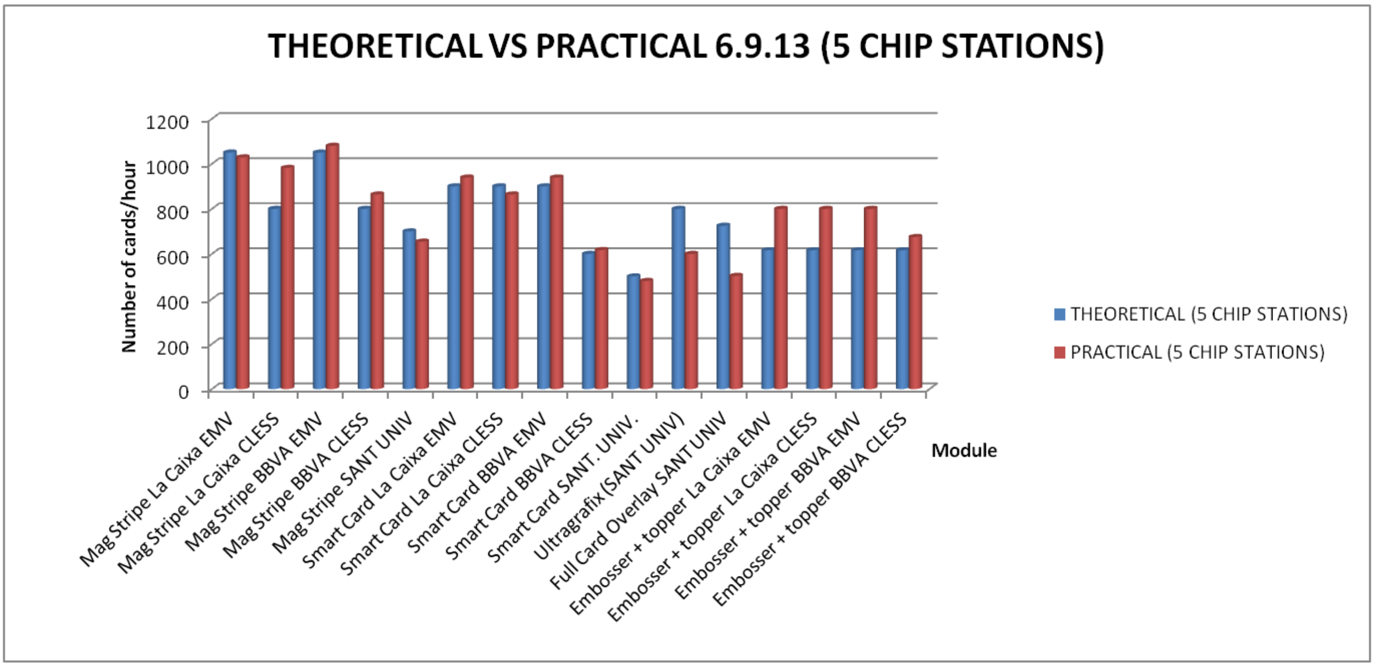

Figure 21. Practical New vs. Theoretical 5 Stations

The progress was already made and I was blown out by the results. The theoretical was lower in most cases, but there were still improvements to be made. Looking at the graph above, one can notice blue peaks at the Ultragrafix and full card overlay modules. The only way to approach the red bar closer to the blue bar was to add more stations. Now, the objective was to increase more the performance by adding the sixth station, compare it with five, and the red bars had to be equal or higher than the blue ones.

PRACTICAL NEW VS THEORETICAL				
MODULE	THEORETICAL (6 CHIP STATIONS)	PRACTICAL (6 CHIP STATIONS)	THEORETICAL (7 CHIP STATIONS)	PRACTICAL (7 CHIP STATIONS)
Mag Stripe La Caixa EMV	1150	1200	1250	1200
Mag Stripe La Caixa CLESS	900	1080	1000	1080
Mag Stripe BBVA EMV	1150	1200	1250	1200
Mag Stripe BBVA CLESS	900	1080	1000	1080
Mag Stripe SANT UNIV	800	771	900	771
Smart Card La Caixa EMV	1100	1080	1200	1080
Smart Card La Caixa CLESS	1100	982	1200	982
Smart Card BBVA EMV	1100	1080	1200	1080
Smart Card BBVA CLESS	700	720	800	720
Smart Card SANT. UNIV.	600	540	700	540
Ultragrafix (SANT UNIV)	800	655	800	655
Full Card Overlay SANT UNIV	750	540	750	540
Embosser + topper La Caixa EMV	616	831	616	831
Embosser + topper La Caixa CLESS	616	831	616	831
Embosser + topper BBVA EMV	616	831	616	831
Embosser + topper BBVA CLESS	616	720	616	720

Table 25. Practical New vs. Theoretical 6-7 Stations

The table above clearly shows that the performance between six and seven stations is not important and is sometimes equal, but compared to five, it is sufficiently increased to define that the optimum is six stations. The theoretical with seven stations is of course proportional and higher than the practical. Below, the graphs of the theoretical compared with six and seven stations.

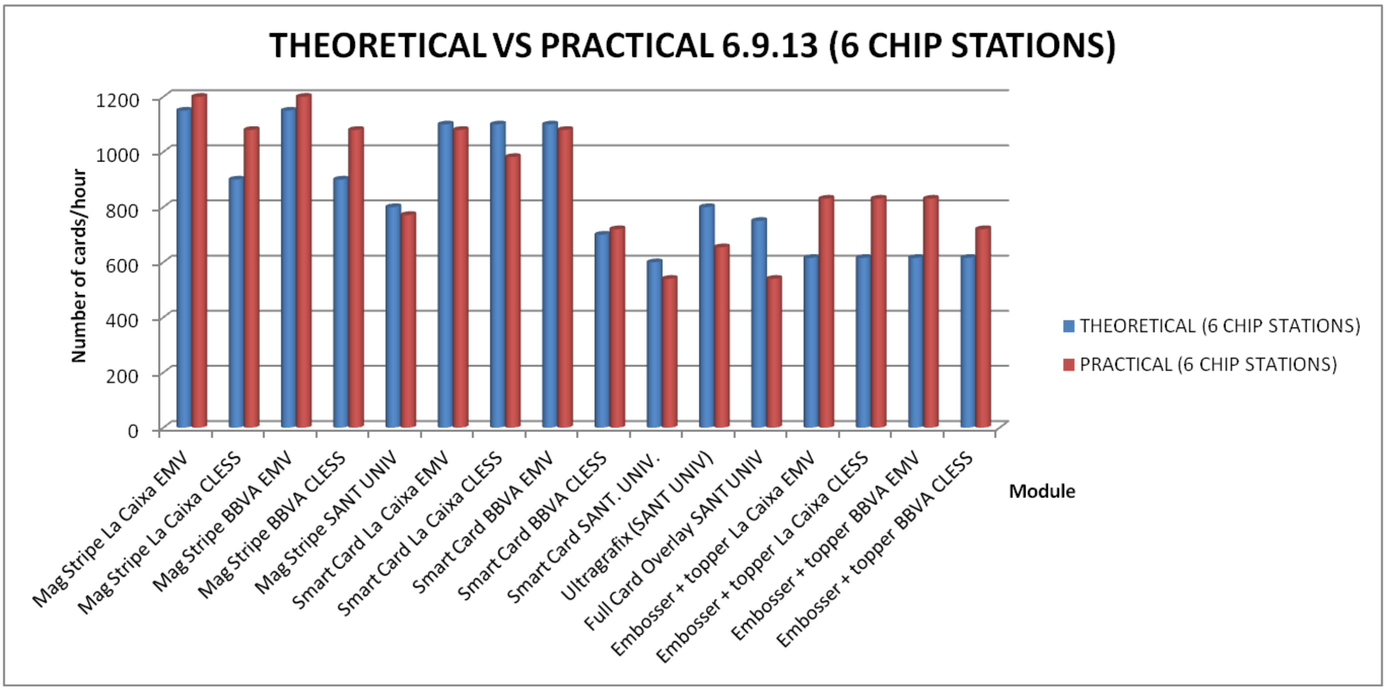

Figure 22. Practical New vs. Theoretical 6 Stations

The graph above clearly proves that the optimum is with six stations because the number of cards per hour is much higher than in all of the other cases. Even though there are still two blue peaks, most of the red bars are either much higher than the theoretical or almost at the same height. The focus of this project was on the smart card module.

If looking at the graph with five stations, the maximum reaches the middle between 800 and 1000 cards per hour. In the graph of six stations, the first three are between 1000 and 1200 cards per hour. That means that with one more station installed, the module increases its performance by 100-200 cards per hour. In a production activity with strict delivery time to the clients, this is huge in terms of performance and machine time.

Below is the graph of seven stations and this is not the optimum because there is no difference between six and seven, and the theoretical is much higher. This is because in the theoretical, the table is proportional and is not considering the real environment. It is not worse it to have seven stations because this requires more spending and more time for the maintenance department if the result will be the same as six.

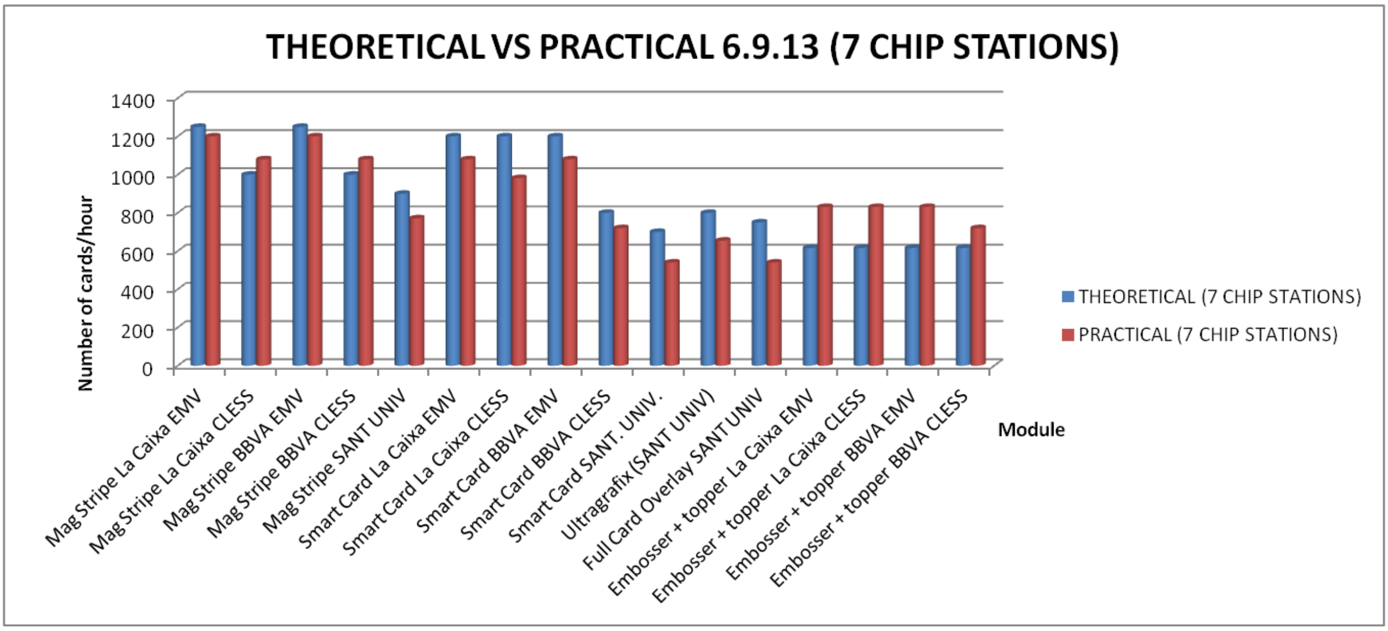

Figure 23. Practical New vs. Theoretical 7 Stations

IX. POSSIBLE FUTURE IMPROVEMENTS

I decided to run a study on how to improve more the performance of the machine. Now that I had optimized the smart card module, I realized that the module that limits the most the total throughput of the machine was the embosser module. I made an analysis and proposed the company on how in the future they could increase the performance even higher than what it will be after this project. This study was done theoretically.

Earlier, I commented that the machines only have two embossers and this allows the machine to run at 616 cards per hour. If we add two more embossers to the machine, the total throughput jumps up to 1055 cards per hour. This is a huge difference, costly, but this would be a great acquisition for Barcelona to increase their volumes.

Each line is 21 characters long.

Number of Embossers	Card per Hour
1	387
2	616
3	650
4	1055

Each line is 21 characters long.

Number of Embossers	Card per Hour
1	387
2	616
3	650
4	1055

Table 26. Number of Embossers vs. Cards per Hour

Now that the machines have six stations and have the smart card module and the total machine throughput optimized, therefore the ideal would be to have four embossers instead of two. The table below recalls the theoretical machine throughput with two embossers installed.

THEORETICAL EMB CLIENTS (2 EMBOSSERS)				
NUMBER OF STATIONS INSTALLED	TOTAL THROUGHPUT LA CAIXA EMV(cards/hour)	TOTAL THROUGHPUT LA CAIXA CLESS (cards/hour)	TOTAL THROUGHPUT BBVA EMV (cards/hour)	TOTAL THROUGHPUT BBVA CLESS(cards/hour)
1	200	100	100	100
2	500	300	300	200
3	600	500	500	300
4	616	616	616	400
5	616	616	616	600
6	616	616	616	616
7	616	616	616	616

Table 27. Theoretical With Two Embossers

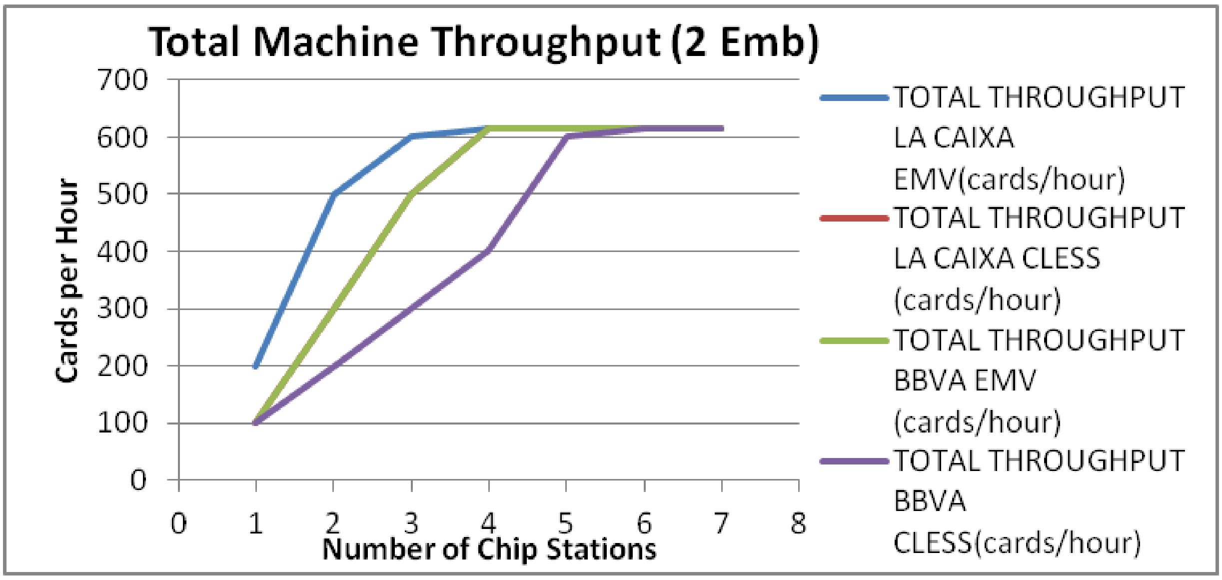

Figure 24. Theoretical With Two Embossers

THEORETICAL EMB CLIENTS (4 EMBOSSERS)				
NUMBER OF STATIONS INSTALLED	TOTAL THROUGHPUT LA CAIXA EMV(cards/hour)	TOTAL THROUGHPUT LA CAIXA CLESS (cards/hour)	TOTAL THROUGHPUT BBVA EMV (cards/hour)	TOTAL THROUGHPUT BBVA CLESS(cards/hour)
1	200	100	100	100
2	500	300	300	200
3	600	500	500	300
4	700	700	700	400
5	900	800	900	600
6	1055	900	1055	700
7	1055	1000	1055	800

Table 28. Theoretical With Four Embossers

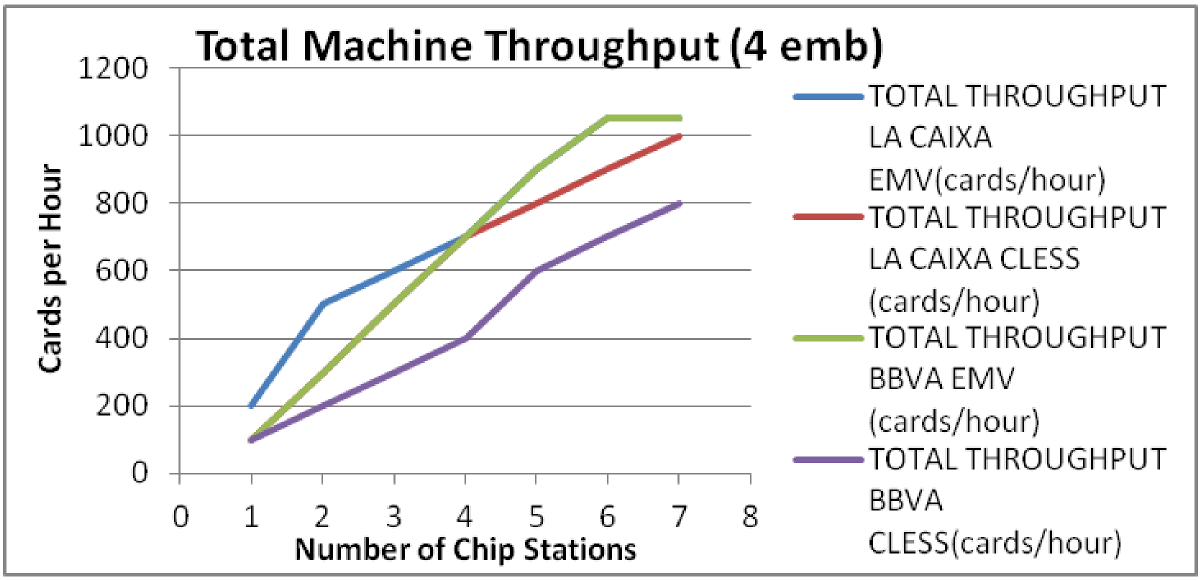

Figure 25. Theoretical With Four Embossers

In the graph with two embossers, the lines are stopped at 616 cards per hour, and this clearly shows the limitation. On the other hand, the lines in the graph with four embossers do not have a cut off limit and it seems that it could even go higher. By just adding two more embossers, the total throughput of the machine increases by 42%. The performance will be seen for all clients. Six stations installed corresponds to 700 cards per hour for BBVA Contactless, 900 cph for La Caixa Contactless, 1100 cph for BBVA EMV and La Caixa EMV. The Barcelona production floor has never seen machines with this performance ever since the site was created.

This proposal was shown to the planning meeting with the Site Manager, Project manager, Marketing and sales. They will look into it and they will probably decide to equip one machine with such configuration, something that they could not have done with the old configuration and without my analysis.

X. CARD YIELD

While I was doing my project, I was in contact with the quality department in order for them to provide me with the quantity of cards produced per month and the total bad cards produced because of the connection to the servers, errors in the smart card module, and anything to do with the personalization of the card. The objective of the project was to also reduce the card yield loss, which defines the cost of making one card. If the card gives error during the personalization process, then this card needs to be replaced by a new one, and therefore the price of making one card increases. Barcelona had a lot of problems and their card yield loss was high. This was mainly due to the old configuration, where the stations would not connect, or would freeze during the connection to the Key Management Servers, and the operators would lose time in remaking the cards, the company would lose money, and the production was becoming too expensive.

With the indicators from the quality department, I was able to monitor the card yield loss for my entire project, starting in November of 2012 and ending in May of 2013. The card yield loss could happen for any reason, and there were reasons that were not related to my project because they were external reasons. In order for my analysis to not be wrong, I talked with quality department and asked them to provide me with the errors due to the smart card module, and in that way, I could see if my project actually improved the card yield loss for these types of errors.

First, we will see the smart card module yield loss, and then we will see the entire company yield loss per month. The table below shows the smart card yield loss since my project started and after my project.

A. SMART CARD YIELD LOSS

SMARTCARD YIELD LOSS	
MONTH	TOTAL YIELD LOSS (number of cards/month)
10/31/2012	1573
11/30/2012	1053
12/31/2012	2255
1/31/2013	948
2/28/2013	1380
3/30/2013	1020
4/30/2013	930
5/31/2013	800

Table 29. SmartCard Module Yield Loss

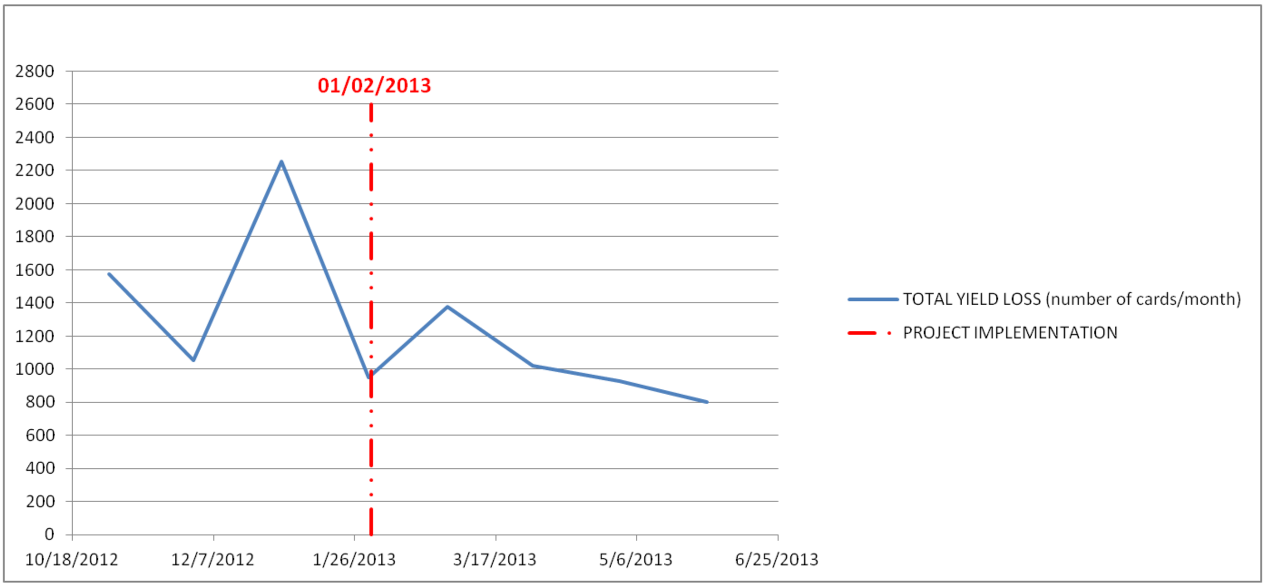

Figure 26. SmartCard Module Yield Loss

The red dotted line shows when I implemented my project. My project was set up in the Barcelona production floor February 1st 2013, and since then, the graph clearly shows that the smartcard yield loss has decreased. On the left hand side of the red dotted line, the card yield loss was not even and was very high at some point. On the right hand side of the red line, i.e. after the implementation of my project, the smartcard yield loss decreased gradually and once again proved that my project really impacted and was very efficient. The production floor went from an average of 1400 cards per month lost to 800, which is a 43% decrease, almost half in just three months. As time goes on, the smartcard yield loss will decrease even more.

B. TOTAL PRODUCTION CARD YIELD LOSS

As I stated before, I was monitoring the entire production card yield loss of the company before and after implementing my project, and the table below shows the number of good cards produced, the number of bad cards produced, and the card yield loss percentage from November to May for all of the clients studied throughout this project.

CARD YIELD				
MONTH: NOVEMBER				
CLIENT	NUMBER OF GOOD CARDS	NUMBER OF BAD CARDS	TOTAL CARDS PRODUCED	% YIELD LOSS
LA CAIXA EMV	60253	688	60941	1.13%
BBVA EMV	44731	286	45017	0.64%
LA CAIXA CLESS	28032	659	28691	2.30%
BBVA CLESS	16742	63	16805	0.37%
SANTANDER UNIVERSITIES	12374	183	12557	1.46%

CARD YIELD				
MONTH: DECEMBER				
CLIENT	NUMBER OF GOOD CARDS	NUMBER OF BAD CARDS	TOTAL CARDS PRODUCED	% YIELD LOSS
LA CAIXA EMV	374744	9530	384274	2.48%
BBVA EMV	40400	340	40740	0.83%
LA CAIXA CLESS	33200	850	34050	2.50%
BBVA CLESS	15760	127	15887	0.80%
SANTANDER UNIVERSITIES	3229	126	3355	3.76%

CARD YIELD				
MONTH: JANUARY				
CLIENT	NUMBER OF GOOD CARDS	NUMBER OF BAD CARDS	TOTAL CARDS PRODUCED	% YIELD LOSS
LA CAIXA EMV	75170	857	76027	1.13%
BBVA EMV	45964	511	46475	1.10%
LA CAIXA CLESS	29305	313	29618	1.06%
BBVA CLESS	17032	151	17183	0.88%
SANTANDER UNIVERSITIES	2961	40	3001	1.33%

Table 30. Total Card Yield Loss November - January

CARD YIELD				
MONTH: FEBRUARY				
CLIENT	NUMBER OF GOOD CARDS	NUMBER OF BAD CARDS	TOTAL CARDS PRODUCED	% YIELD LOSS
LA CAIXA EMV	73984	664	74648	0.89%
BBVA EMV	47591	370	47961	0.77%
LA CAIXA CLESS	62653	595	63248	0.94%
BBVA CLESS	17318	116	17434	0.67%
SANTANDER UNIVERSITIES	4416	43	4459	0.96%

CARD YIELD				
MONTH: MARCH				
CLIENT	NUMBER OF GOOD CARDS	NUMBER OF BAD CARDS	TOTAL CARDS PRODUCED	% YIELD LOSS
LA CAIXA EMV	72345	512	72857	0.70%
BBVA EMV	46452	309	46761	0.66%
LA CAIXA CLESS	63895	430	64325	0.67%
BBVA CLESS	18215	96	18311	0.52%
SANTANDER UNIVERSITIES	3278	25	3303	0.76%

CARD YIELD				
MONTH: APRIL				
CLIENT	NUMBER OF GOOD CARDS	NUMBER OF BAD CARDS	TOTAL CARDS PRODUCED	% YIELD LOSS
LA CAIXA EMV	76952	489	77441	0.63%
BBVA EMV	48965	295	49260	0.60%
LA CAIXA CLESS	72300	400	72700	0.55%
BBVA CLESS	23584	85	23669	0.36%
SANTANDER UNIVERSITIES	5962	20	5982	0.33%

CARD YIELD				
MONTH: MAY				
CLIENT	NUMBER OF GOOD CARDS	NUMBER OF BAD CARDS	TOTAL CARDS PRODUCED	% YIELD LOSS
LA CAIXA EMV	77562	300	77862	0.39%
BBVA EMV	45236	200	45436	0.44%
LA CAIXA CLESS	73698	300	73998	0.41%
BBVA CLESS	20325	65	20390	0.32%
SANTANDER UNIVERSITIES	4652	15	4667	0.32%

Table 31. Total Card Yield Loss February – May

If we pay close attention to the percentages from month to month for each client, we can notice that it did decrease, but a graph of this data will demonstrate this easier.

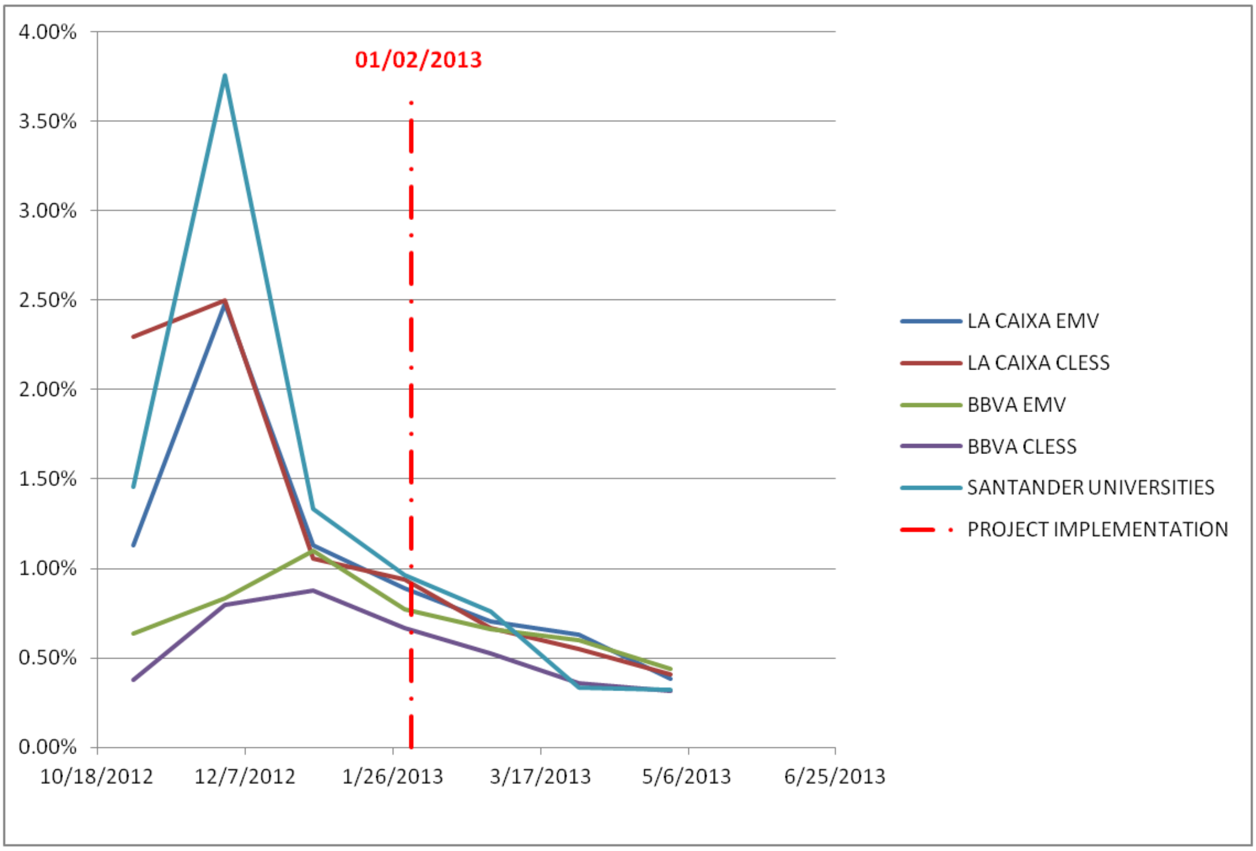

Figure 27. Total Card Yield Loss November – May

In this case, the red line is again the deployment of the project. The card yield loss decreased even before the project was implemented, this is because I was already working on it and one machine had the new configuration. On the left hand side of the red line, the card yield loss is completely uneven, with peaks every month, and percentages reaching almost 4%, which is unacceptable in a shop floor. As the project came closer to be deployed, the card yield loss settled down, slowly decreased, and in May had reached the lowest card yield loss the company has ever experienced, which was less than 0.5% for all clients.

XI. DELIVERY TO CLIENT (SLA)

One of the main objectives of this project is to reduce the delivery time to the client in order for them to always be satisfied. In a digital security company, the SLA (Service Level Agreement) is very strict and needs to be above 99% at all times.

In the sections above, we demonstrated that the production had increased, the time had been saved, and that the same production can be done faster. In consequence, the cards can be delivered in a shorter period of time. To analyze this process, I monitored at what time the production files for these clients were received and at what time the cards for these clients were sent. Then, using the calculated information on the optimum machine performance, production gain, and production time savings, I was able to deduct the time it will take now to deliver the cards.

The table below shows at what time the cards will be able to be sent now.

DELIVERY TIME							
CLIENTS	**DELIVERY HOUR BEFORE**	**DELIVERY HOUR AFTER**	DELIVERY HOUR BEFORE (hours)	DELIVERY HOUR AFTER (hours)	TOTAL TIME GAINED/DAY (mins)	TOTAL TIME GAINED/DAY (hours)	**GAINED PERCENTAGE**
LA CAIXA	**13:30**	**11:40**	13.5	11.67	109.55	1.83	**13.52%**
BBVA	**11:00**	**09:48**	11	9.81	71.62	1.19	**10.85%**
SANT. UNIV	**11:00**	**09:56**	11	9.94	63.42	1.06	**9.61%**

Table 32. Delivery Time

The production files are received between 6pm and 6am with a SLA of +0, which means that the cards need to be delivered the same day. The calculation has been done by client and not by type of cards because all cards are sent. I considered that the same volume was being produced.

For La Caixa, the deadline to send the cards is at 13h30 every day. Before the project was implemented, production was always in a rush and sometimes will go over the deadline because all of the cards were not produced yet. Using the time gained per day, production will now be able to deliver the cards at 11h40 instead of 13h30. That is a 13.52% gain of delivery time.

The second client that I looked at during this entire project was BBVA. The delivery time for this client is at 11:00am every day. The gain percentage here is 10.85% and production will be able to send the cards at 9:48am.

The third and final client is Santander Universities. This is the client with the lowest volumes but with the longest personalization time. Corporate wants to especially increase their volumes for this client. The delivery time is at 11:00am and now the cards will be able to be delivered at 9:56am. That is a 9.61% gain.

The graph below resumes the delivery times for each client.

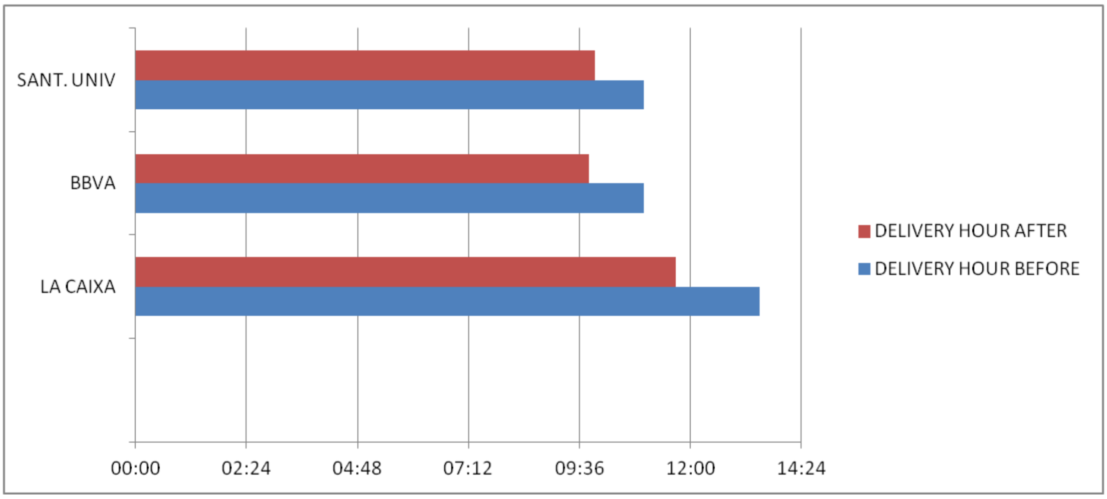

Figure 28. Delivery Time

XII. KMS CEREMONY

As stated before, five times a month, a key ceremony in the Key Management Server is done for approximately one hour to include new keys into the system. During this time, the Server I stopped, therefore production cannot produce. This means that for five hours every month, production is losing cards. While I was doing the project, the production manager came up to me and asked me if there is a way I could arrange that because it was a blocking point for them. I decided to look into it and contacted with the IT department to see if they had an available server that could be used as a second production server so that when a KMS ceremony is done, the machines will automatically switch to the other server, and in this case production will never be affected.

IT confirmed me that they had another server that could be used. The server room is forbidden of entry and only the security manager has access to it therefore I had to talk with him and tell him to copy all keys in the production server to this new server. This took a little while but once he had done it, I had to test the new server.

In the operas.ini, I had to change the IP address of the KMS server to the IP of the new server just to test if all clients worked. After running all the tests, I validated, along with the quality department that all clients work fine with the new server. The point was not to switch to the new server but to use both alternatively. This means that if one server fails, then the machine automatically switches to the other server, transparently to the operator.

I decided to first run test outside the machine with software called WinSpi, which is basically a virtual machine. I set the IP addresses of each server as followed:

```
[KMS]
Type=FS
Host_1= IP KMS 1:PORT 1
Host_2= IP KMS 2:PORT 2
Host_3= IP KMS 1:PORT 1
Host_4= IP KMS 2:PORT 2
Host_5= IP KMS 1:PORT 1
Host_6= IP KMS 2:PORT 2
Host_7= IP KMS 1:PORT 1
Host_8= IP KMS 2:PORT 2
Host_9= IP KMS 1:PORT 1
Host_10= IP KMS 2:PORT 2
```

Then, commenting out the first line that would mean that the machine would ignore the connection to KMS 1 and would switch automatically to KMS 2. This is exactly what had happened and I implemented this change in the production shop floor. Now, production will never again be affected by a Key Ceremony. In consequence, this change will also improve production in terms of production gain. I made a quick theoretical analysis to see how many cards they could produce in this time frame. The following table shows this analysis.

LA CAIXA EMV		BBVA EMV	
MACHINE PERFORMANCE (cards/min)	CARDS LOST/MONTH (cards)	MACHINE PERFORMANCE (cards/min)	CARDS LOST/MONTH (cards)
10.00	3000	11.25	3375
LA CAIXA CONTACTLESS		**BBVA CONTACTLESS**	
MACHINE PERFORMANCE (cards/min)	CARDS LOST/MONTH (cards)	MACHINE PERFORMANCE (cards/min)	CARDS LOST/MONTH (cards)
10.29	3085.714286	8.00	2400
TOTAL LA CAIXA		**TOTAL BBVA**	
CARDS LOST/MONTH (cards)	6085.714286	CARDS LOST/MONTH (cards)	5775.00
SANTANDER UNIVERSITIES			
MACHINE PERFORMANCE (cards/min)	CARDS LOST/MONTH (cards)		
4.50	1350		

Table 33. KMS Ceremony Production Gain

The calculation was based on how many cards production was losing with these KMS ceremonies. Now, this loss is converted in gain and this number was added in the tables in the quality control analysis to the red number.

XIII. PROJECT COST

Barcelona was never able to proceed with a project of this scale because it requires a lot of time, resources, and money. Many different departments were involved but this project especially requires careful attention, therefore the time was fully dedicated to the project. When working on a risky project such as this one, where any mistake could jeopardize the business, the employee is under pressure at all times and needs to focus, so he/she cannot be distracted from the day to day work, nor by its coworkers. During this period, I was fully dedicated to the project and realized that communication was very important between departments. I gained valuable experience in interacting between employees and in carrying on a big project.

The project started on Ocotber 15th 2012 and ended April 30th 2013. This is a total of a 142 labor days. On average, an engineer is paid 35 000 euros per year, therefore, this project would cost the company 13616 euros. The picture below shows the plan of the main tasks I carried out during the project.

Id		Modo de tarea	Nombre de tarea	Duración	Comienzo	Fin	Predecesoras	Nombres de los recursos
1			Project Start	142 días	lun 10/15/12	mar 4/30/13		
2	✓		Gather all scripts	2 días	lun 10/15/12	mar 10/16/12		alex
3	✓		Create excel macro	2 días	lun 10/15/12	mar 10/16/12		alex
4	✓		Run the code and extract the libraries used	1 día	lun 10/15/12	lun 10/15/12		alex
5	✓		Look/Read specifications of each library	2 días	lun 10/15/12	mar 10/16/12		alex
6	✓		Create an excel of the dll's	6 días	lun 10/15/12	lun 10/22/12		alex
7	✓		Download new versions	4 días	lun 10/15/12	jue 10/18/12		alex
8	✓		Create operas.ini	8 días	jue 10/18/12	lun 10/29/12		alex
9	✓		Create operas folder	9 días	jue 10/18/12	mar 10/30/12		alex
10	✓		Configure the libraries	3 días	jue 11/8/12	lun 11/12/12		alex
11	✓		Finalize operas configuration	4 días	jue 11/15/12	mar 11/20/12		alex
12	✓		Check correct CAPK certificates	3 días	lun 10/29/12	mié 10/31/12		alex
13	✓		Create platform standard	40 días	lun 11/5/12	vie 12/28/12		alex
14	✓		Configure platform.ini, SPI for each machine	15 días	mié 11/7/12	mar 11/27/12		alex
15	✓		Run full tests	27 días	vie 12/7/12	lun 1/14/13		alex
16	✓		Install new operas configuration on QC	6 días	vie 11/16/12	vie 11/23/12		alex
17	✓		Run indicators for QC	20 días	vie 12/7/12	jue 1/3/13		alex
18	✓		Prepare files/cards	5 días	vie 1/25/13	jue 1/31/13		alex
19	✓		Implement new software	2 días	mié 1/2/13	jue 1/3/13		alex
20	✓		Validation tests	10 días	jue 1/31/13	mié 2/13/13		alex
21	✓		Deploy new standard	20 días	vie 2/1/13	jue 2/28/13		alex
22	✓		Monitor Card Yield loss	123 días	jue 11/1/12	sáb 4/20/13		alex
23	✓		implement second KMS	15 días	vie 3/1/13	jue 3/21/13		alex
24	✓		Run final tests and indicators	35 días	jue 3/7/13	mié 4/24/13		alex
25	✓		Project Finish	1 día	jue 5/30/13	jue 5/30/13		alex

Figure 29. Project Plan