
This experiment seeks to understand how people interact with near field communication (NFC) tags placed around the School of Library and Information Science library. The library already had several QR codes placed throughout, so these NFC tags were placed in their proximity as well as other in locations in the library that has information that could be accessed on the SILS website. The tags were programmed using an app on an NFC enabled device and were each labeled with that they were programmed to do. A pre-survey and post-survey were used as forms of assessment to determine user familiarity with the technology and how the tags were used, respectively.

Headings:

Near Field Communication

NFC tags

QR Codes

Mobile Computing

Smartphones

Internet of Things
INTRODUCING NFC TAGS TO THE SCHOOL OF LIBRARY AND INFORMATION SCIENCE LIBRARY

by
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A Master’s paper submitted to the faculty of the School of Information and Library Science of the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Master of Science in Information Science.

Chapel Hill, North Carolina
April 2014

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What is NFC?

Near Field Communication, or NFC, is a short range communication technology that allows NFC enabled devices to exchange information. Unlike Bluetooth, another ranged communication technology, the range necessary for communication through NFC is such a short distance, that devices touch each other or come very close to it. This, along with requiring devices to be unlocked (i.e. taken out of sleep mode) before a tag could be read, provides NFC increased security. Also unlike Bluetooth, NFC devices do not have to be paired with one another, completely avoiding any setup time.

There are two ways in which NFC interactions can take place: 1) with two NFC enabled devices, such as two smartphones or 2) an NFC enabled device and a device with an NFC chip inside. When an NFC interaction takes place, one of the two devices sends a piece of information or a command to the other. For example, if two NFC enabled smartphones enable an interaction by touching back-to-back, one can send a picture or a file to the other phone. Another example is a smartphone tapping an NFC enabled pay system to board a bus. In that case, the pay system is programmed to ask the phone to send over payment information.

1.1 Current uses of NFC

There are many uses for NFC in that second scenario where a phone taps a device programmed with an NFC chip. Yarmey (2011) gives a few ideas about NFC and what it
means for libraries, such as using it as library cards and for social media and gaming. They also mention possible uses outside of libraries, such as for mobile payments, access and authorization, meaning as an ID for entrance into buildings, parking garages, etc., in healthcare as a way of storing pertinent health related information and more.

Japan is ahead of the curve in terms of technology, especially when it comes to the use of NFC. A library in Japan has implemented NFC tags on bookshelves, where users can read the NFC tags to find out more about the books on the shelves (Hall, 2013). Outside of libraries, NFC enabled devices serve as credit cards and train boarding passes, just to name a few. The application of NFC as train boarding passes has begun to be implemented in the U.S., thanks to Visa, in New York, New Jersey, Chicago and Los Angeles.

Atria, a publishing company, published the first “smart book”, a book with NFC tags that allows reader to interact with the book (Marcusa, 2011). By activating the NFC tags, the reader can find out more things about the book than a book can show, such as by playing a video or music, taking a quiz, interacting with graphs or charts, and so much more.

It also turns out that there are other people out there who think NFC is a viable technology in libraries. McHugh and Yarmey (2012) discuss the ways in which physical materials can be linked with digital materials. Gomez-Nieto et al (2010) describes this phenomenon as “Internet of Things” where physical items are interacting with through digital means, and NFC is a way of bridging that gap. “It is a model of interaction with physical objects holding digital information and located in a "smart environment.” In Gomez-Nieto et al’s other paper (2009), they discuss how NFC and the Internet of Things
helped bring the University of Cordoba to the standards of the European Higher Education Guidelines. What McHugh and Yarmey discuss is the use of NFC outside of academia, and how it can be applied to universities and libraries. Some of its proposed uses include mobile payment, such as for late fees, a way to check out materials, connection to the libraries social media and more.

Going along with Yarmey’s suggestions of using NFC for gaming, further research into how games are being implemented in libraries shows that Smith and Baker (2011) conducted two different games in the library, one physical and one digital, to help students become acquainted with the libraries various services. Although NFC was not used in those studies, those games, or variations of them, could be implemented using NFC.

### 1.2 NFC versus QR Codes

Another technology similar to NFC is QR codes. QR codes are dynamically generated barcodes that can be scanned using a QR code scanner (usually a dedicated app on a device) that uses the device’s camera. These QR codes function much in the same way as NFC tags in that they transfer a set of commands to the device, the majority of cases being a link to a website. The manner that QR codes are initiated prevents it from taking information from the device, meaning it could never be used for things mentioned above like boarding passes or library cards. Another downside to QR codes is that they require a dedicated app to be installed on the device in the form of a QR reader. An initial finding of this NFC experiment is that some people do not want to take those extra steps
(downloading the app, opening the app, etc.) to scan QR codes and find the whole ordeal too troublesome.

That is where NFC comes in. NFC requires no additional app, seeing as it is a built in function in most new devices, and does not require opening the camera. To make any NFC exchange, the device(s) must have NFC turned on, just like one would turn on Bluetooth. Then the device must be unlocked, meaning out of standby or sleep, and physically “tapped” to another device or a tag for the command to take place. NFC uses very low energy consumption and the NFC tags themselves do not have any sort of battery or power source. The tags draw the power necessary to send the command to the device from the device itself when contact is made.

1.3 Limitations

NFC is a technology that has not seen too much momentum here in the U.S. Not many people are aware of what this technology is or what it does. Not only that but the number of devices that have NFC built in is also limited. Apple’s products such as the iPhone and iPad, some of the most popular devices at the moment, do not support this feature, so that immediately cuts the amount of useable participants in this study by a good portion. Rumors this year suggest that Apple is developing a paying system that will support NFC for the iPhone 6 (Russell, 2014). Of the potential participants whose phones possess the technology, there are still going to be users who are unfamiliar with the technology. Even then, of the actual participants who a) have NFC-enabled devices and b) are aware of the technology, some might just not be at all interested in its use.
Methodology

The location for this experiment would take place starting right outside the doorway of the SILS library and inside the library up to just before the computer labs. The participants include anyone who frequents the library, the majority being undergraduate and graduate SILS students. The general outline for the experiment was one of three phases: 1) conduct a pre-survey to get a feel for the current use of NFC and QR codes and what smart phones are owned, 2) program and deploy the tags around the library and 3) conduct a post-survey to find out how the tags were responded to and how/if they were used.

1.1 Pre-survey

1.1.1 The email

The following email, containing the link to the survey, was sent to students:

For my master’s paper, I am going to be implementing a small experiment in the SILS library. It will involve the placement of NFC tags to make the library a more "interactive" environment. The purpose of this survey is to determine how many SILS students that frequent the SILS library have NFC enable devices that would make use of the NFC tags.

Here is a link to the survey:

https://www.surveymonkey.com/s/KG5WC7Q

The survey is for all SILS students, undergraduate and graduate.

Thanks,
Eddie Prieto
1.1.2 The Survey

The entire pre-survey follows below:

1. What brand of smart phone do you own? If you own more than one, please select the one you use the most.

- Apple iPhone running iOS
- Google, Samsung, HTC, Motorola, LG, Sony or other running Android
- Nokia or Windows running Windows Phone
- Blackberry running Blackberry OS
- I don't own smart phone
- Other (please specify)

2. Is your smart phone NFC (near field communication) enabled?

- Yes
- No

If your phone is a device manufactured by Google, Samsung, HTC, Motorola, LG, Sony, or any other Android Device made within the last 2 or 3 years, chances are your smart phone is NFC enabled. You can select "Yes".

If you want to be 100% sure, you can refer to this link of NFC enabled devices:

List of NFC enabled devices (links to http://www.nfcworld.com/nfc-phones-list/#available)

3. Have you ever used the NFC feature of your phone?

Yes. Briefly describe in what way you used it and what you thought of the experience (easy, difficult, fun, etc.)

No. Briefly describe why not (never see them, don't want to, etc.)
4. Have you ever used QR codes?
Yes. Briefly describe in what way you used it and what you thought of the experience (easy, difficult, fun, etc.)

No. Briefly describe why not. (never see them, don't want to, etc.)

Please notice which of the next two questions pertains to you.

5. For those who own NFC enabled devices: How often do you visit the SILS library?
- All the time
- A few times a week
- A few times a month
- A few times a semester

6. For those who do not own NFC enabled devices: How often do you visit the SILS library?
- All the time
- A few times a week
- A few times a month
- A few times a semester

1.1.3 Discussion
Before the experiment could begin and the tags could be created and placed around the library, there were a few things that needed to be found out. For one, it needed to be known how many SILS students actually have NFC enabled devices. If the number were too small, then there really wouldn’t be much use to place the tags around the library. An
argument could be made, however, that it would still be viable even if it benefited just a few.

The current devices on the market that are NFC enabled are roughly all devices running Android, Windows Phone and Blackberry operating systems released within the past 2 or 3 years (NFC World). As mentioned before, Apple products are not NFC enabled. Also because this is such a new technology and not one that is advertised too much\(^1\), many people won’t even know whether their device is NFC enabled or not. Because of this, a link in the email with the pre-survey was provided that sent them to a website with a full list of NFC enabled devices if they wanted to check

The second thing to find out was how often they visit the library. Again, just as it is important that there be a good number of SILS students with NFC enabled devices, it is just as important that they visit the library frequently enough to make use of the tags. If everyone owned NFC enabled devices, but no one visited the library (an extreme example), then, again, there wouldn’t be much use for the tags.

The third component was to get a sense of how the students interacted with technology of this kind before, whether they used NFC tags (if they have an NFC enabled device) or even QR codes (which anyone can use). Knowing how and why they used them could provide valuable information when placing and programming the tags. This could also show whether the students are familiar with NFC itself, which poses a whole other challenge. If no one is familiar with the technology, that means they will somehow have to be taught and shown that the technology is there to help them. It is one thing to know that something is just there and how it works, but another to know that it is there to

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\(^1\) Samsung does a decent job of portraying NFC interactions in their commercials for their Galaxy line of devices by “bumping” phones, thought they don’t explicitly advertise it as being NFC
help them and make things easier. Also getting a sense for how and why they used QR codes could help in making the NFC tags that much more productive than QR codes and eventually replace them in functionality.

A difficult aspect of this survey and the post-survey is the logic needed to separate those who own NFC enabled devices and those who don’t. The reason for that is that both would have entirely different positions and viewpoints in this experiment and so their answers needed to be separated, something that would not have been possible if everyone took the same generic survey. SurveyMonkey (https://www.surveymonkey.com), the tool that was used for this first survey, was limiting in that it did not provide the logic operators necessary to do so, meaning the questions had to specifically state who they were geared towards. The survey was small, six questions total, and it should not have been that difficult for someone taking the survey to find which questions applied to them.

1.2 Creating and putting the tags

1.2.1 Learning how

There are no real “definitive” guides or works on how to program NFC tags, but there are a wealth of YouTube videos put out by tech journalists that show how to program these tags and what to use them for. One particular person, Marques Brownlee, also known as MKBHD, is an extremely popular YouTuber with over 1.1 million subscribers and consistently uploads well-informed videos about recent trends in technology. He uploaded a video entitled “Top 5 NFC Features: Explained” (http://www.youtube.com/watch?v=qp5il7yhM4Y) that is part of his “Explained” series
of videos in which he explains recent hot topics in technologies in layman’s terms. In it, he discusses what NFC tags are, how they are programmed and his top five uses for them. This video served as my starting point for all of my research concerning the tags. There are also some videos by CNET, a popular technology news website, that explain how to program the tags and their uses (http://www.youtube.com/watch?v=td_O6m6zDLo), as well as by countless others on YouTube.

A wiki article on XDA-Developers has a nice resource of all the different models of NFC tags, including how much information they can store, what materials they come in and all the places you can purchase NFC tags (http://forum.xda-developers.com/wiki/NFC_Tags). Google also has a page on their developer’s page giving all the technical details about NFC tags, which, for the purposes of this experiment, were too detailed and unnecessary (http://developer.android.com/guide/topics/connectivity/nfc/nfc.html).

1.2.2 Selecting which tags to buy

NFCtags.com is a great resource in general for all things NFC tags. They explain how NFC works, uses for the tags, and even have an article to help select the type of tag to use for whatever application you need it for. According to that website, a good recommendation is to use Mifare Classic NFC tags, which can be bought from companies such as WhizTags (http://www.nfcapps.com/nfc-applications-which-tag).

There are several online stores, including Amazon, that sell a variety of NFC tags from different companies. Doing a quick “nfc tags” search in Amazon.com yields several results for NFC tags for around $10 to $15 USD. The ones that were used for this
experiment were the WhizTags 10 pack that includes a keychain tag for $14 and were purchased from Amazon (https://www.whiztags.com/product/whiztags-10-pack-ntag203-compatible-with-all-phones/).

They had two versions of these: one with the android character on them and another with lines that look like the Wi-Fi logo. The ones with the Wi-Fi looking symbol were chosen because they seemed generic enough in that the ones with the Android logo would make it seem like they only worked with Android, which to some extent is true, but it should not come across that way, especially if the library decides to keep the tags in place and Apple decides to implement it in their devices in the future. As for the actual tags, they are plastic, about as thick as and just a bit taller than a quarter, come in different colors with the words “TAP HERE” and the Wi-fi-esque logo on one side and 3M adhesive on the back so that they can be stuck to a surface.

1.2.3 Programming the tags

The first thing that needed to be done before programming the tags was to scout the SILS library and look at where all of the QR codes were placed and note what link they provided so that the tags could be programmed with those exact links. Other places besides those were also looked at to see where an NFC or QR code might have been placed but wasn’t, such as anything that gives a hint as to having more information on the SILS website.

The final tags used were based on what QR codes were already in place and any other aspect of the library that could be accessed through the libraries website. Links are a relatively easy thing for someone who is not familiar with the technology to understand
making for a nice introduction to NFC tags, and so all the tags, except one, provided a link to some kind of web page. There also had to be a way for the SILS students to be able to contact me with questions or concerns regarding the project. To allow for that, one tag was programmed to open the users email app with my email and the subject “NFC” already built in, so all they would have to do is compose the email and click send.

Another tag linked to a page on my server at SILS containing a picture of the floor plan of the SILS library that is stuck to the wall leading to the stacks. That was the closest this experiment got to having a tag send a picture to someone’s device. One final tag linked to the SILS Facebook page. It would make for a good companion to it the numerous signs placed around the entrance to the SILS library telling people to like the Facebook page.

A few apps were downloaded from the Google Play Store that were used to program the NFC tags and were each played around with to see how they differed. For the most part, they all provide basic functionalities: writing, viewing and deleting. Writing and deleting are pretty self-explanatory; they write a set of commands to a tag or delete all commands in a tag, respectively. Viewing a tag basically shows all the technical information about a tag such as instructions in a tag, how much space is left and what model it is. The two apps that were used most frequently were Trigger by Egomotion Corp (https://play.google.com/store/apps/details?id=com.jwsoft.nfcactionlauncher) and NFC TagWriter by NXP Semiconductors (https://play.google.com/store/apps/details?id=com.nxp.nfc.tagwriter). They both provided everything needed for this experiment.

When it comes to actually programming the tags, the first thing that is done is to tell the NFC app the function that is to be created and written to a tag. They all provide
several options such as sending an email, sending a text message, making a phone call, etc. For all except the email one, URLs were chosen as the command to take place. Once the URL is entered, an empty tag is tapped to the back of the device (with NFC turned on, of course) as if it was going to read the tag and it confirms saying the tag was successfully written. For the tag sending me an email, the process is very similar. The tag is instructed open the email app and all the attributes of an email as desired can be written, such as the email to send it to, the subject, the body, etc., and then the tag is tapped to the back of the device to write to it.

A concern with placing the tags was that someone would inevitably want to mess around with the tags, change what they do, delete them, etc. Fortunately, NFC TagWriter has a useful feature that allows a tag to be “locked”, meaning it cannot be re-written or deleted. In other words, whatever you write to it and then lock becomes completely permanent. After being locked, the tags were tested to see if they could be deleted using the other apps to make sure that the effects were indeed permanent.

It should be noted that the device used to program the NFC tags was a Samsung Galaxy SIII smartphone. All the tags were programmed and then tested on this device. They were further tested on an Asus Nexus 7, a seven inch tablet by Google, to make sure that the tags worked on a variety of devices, or at least as many as was possible to acquire. It would have been great to be able to access several more NFC enabled devices to test the tags, but that was not possible for this experiment.
1.2.4 Placing the tags

1.2.4.1 Close up of the tags

![This NFC tag opens: SILS Brochures / Library Subject Guides](image1)

![This NFC tag opens: UNC Catalog](image2)

![This NFC tag opens: SILS Facebook page
Give us a like!](image3)

![This NFC tag opens:
Suggestions or Complaints about the NFC tags?
Send me (Eddie Prieto) an email eprieto at live.unc.edu](image4)

![This NFC tag opens: SILS Library New Books](image5)

![This NFC tag opens: SILS Library First Floor Map](image6)
1.2.4.2 The tags in their locations

The final locations of each tag were as follows:

1. On the book return, providing a link to the UNC book renew website
   b. 
   c. 
2. On the door leading to the stairwell, under the Facebook sign, providing a link to the SILS Facebook page
   
a. https://www.facebook.com/uncsil

3. On the door leading to the stairwell, just under the Facebook sign, opening an email app ready to send me an email (pictured above)

4. On the new book shelf, providing a link to the New Book page of the SILS website
   
5. On the brochure stand, next to the help desk, providing a link to the Brochure and Library Subject Guides page of the SILS website

6. On the computer leading up to the stacks, providing a link to the UNC catalog

7. Next to the map on the doorway to the stacks, providing a link to an image of the map that is located on my server space
   a. ruby.ils.unc.edu/~enprieto/silslib_map
1.2.4.3 Discussion

Figuring out how to place the tags was a bit of a challenge because the 3M adhesive on the back of each tag might became permanently stuck to where they were put, which would not have been good in case it damages the surface or SILS decides not to have the tags in place any longer. There also needed to be a way for SILS students to know what each tag did just by looking at it. This would include placing some kind of sign next to each tag that described its function. For the final outcome, card stock was used with the function of each tag printed out on it, evenly spaced. It was then cut into small squares and each tag was adhered to its appropriate signage using the 3M adhesive. With that, the tags could be placed with regular scotch tape, which was the same method used for the QR codes there are currently in place.

1.2.5 Informing the SILS student body

1.2.5.1 The email sent to the SILS student body with instruction

Thank you to all who responded to my survey a few weeks ago regarding NFC enabled devices. As you might have expected, the tags have been placed around the library in these locations. The first three are right outside the door, and the remainder are inside the library:
1. On the book return, providing a link to the UNC book renew website
2. On the door leading to the stairwell, providing a link to the SILS Facebook page
3. On the door leading to the stairwell, just under the Facebook one, opening an email app ready to send me an email to send me suggestions, complaints, or what have you
4. On the new book shelf, providing a link to the New Book page of the SILS website
5. On the brochure stand, next to the help desk, providing a link to the Brochure and Library Subject Guides page of the SILS website
6. On the computer leading up to the stacks, providing a link to the UNC catalog
7. Next to the map on the doorway to the stacks, providing a link to an image of the map

To activate these tags, you must have an NFC enabled device. Chances are if you have an android or windows phone device of the last 2 or 3 years, your device is NFC enabled. (Sorry iPhone users. Perhaps the iPhone 6, rumors suggest). If you are unsure, check this website:

http://www.nfcworld.com/nfc-phones-list/

NFC must be turned on, much like turning on Bluetooth. NFC has improved since it was first introduced and should not impact the battery significantly. One NFC is turned on, simply bring the phone up to the tag and tap the back of the phone to the tag. Depending on whether you have the volume up on your phone, you will either hear a rather satisfying notification sound meaning the NFC was successfully read, or nothing. Either way, depending on the defaults you have set on your phone, it may ask you to choose a web browser, if you do not have that set, which you can choose a default one at that time, or select one for just that instance. Those defaults can be changed later at any time. Then the web page should pop up on your phone. It might sound complicated, but the actual implementation is very simple once you use it just once or twice.

As stated on bullet 3, I have placed a tag that opens up an email app with my email populated and the subject "NFC". Follow the same instructions, picking a default email app, or one just for that instance, and simply compose your email and send it. Please let me know if you encounter any problems with the tags or if you have recommendations on something you'd like to see done with them. To avoid tampering of the NFC tags, all tags have been locked, meaning they cannot be modified further.

Thanks!
Eddie Prieto
MSIS 2nd year
enprieto at live dot unc dot edu
1.2.5.2 Discussion

There now needed to be a way to inform the SILS student body that the tags were in place and how they were to use them. It should be in the form of something that would address lots of people, so email was chosen for this purpose. The first thing that was noted in the email was where each tag was located, including a description of what each tag did. Next, they needed to be explained how to use the tags in a simple yet as descriptive manner as possible. It was explained that NFC is turned on, just like one would turn on Bluetooth, and that the phone taps the tag. The tags have a function that when they are activated and the phone’s volume is turned on, it makes a sound confirming that the tag was read. They were assured that it is easier than it sounds in hopes that they would be more inclined to use them and not scare them away.

It was uncertain whether or not the fact that the tags were locked should be included in the email that was sent out. On one hand, telling them would maybe give them an incentive to try messing with them, even if it was stated that they are completely protected. On the other hand, not telling them would be not reminding them that there is something there that they can mess with. It ended up being mentioning with the hope that telling them that they are protected would be enough to thwart anyone’s mischievous plans.
1.3 Post-survey

1.3.1 The email

Hi everyone,

I have one final survey for you all regarding the NFC tags that were placed throughout the SILS library about a month ago. I'd like to ask you to take one final survey to get a feel for what you all thought about the tags. It should take no more than 2-3 minutes. Anyone can take this survey, regardless of owning an NFC enabled device, or whether you did or didn't use the tags. Here is a link to the survey:

https://unc.az1.qualtrics.com/SE/?SID=SV_81RMSv4Jenp4uln

I really appreciate your time in taking this survey!

Thanks,
Eddie Prieto
2nd year MSIS

1.3.2 The survey

Q1 As a reminder, here are the tags that were placed around the SILS library:
   1. Outside the door with a link to the Facebook Page
   2. Outside the door with a link to send me (Eddie Prieto) an email
   3. Outside the door on the book return with a link to the book renew page
   4. On the new book shelf with a link to the new book page
   5. On the computer heading towards the stacks with a link to the UNC catalog page
   6. On the door sill leading to the stacks with a link to a map of the stacks
   7. On the table next to the reference desk with a link to the SILS brochures

Q2 Do you own an NFC enabled device? (If you are unsure, answer YES if you own an android or windows phone, answer NO if you own an iPhone)
   1. Yes (1)
   2. No (2)

If Yes Is Selected, Then Skip To Check all the tags that you used. If ...
Q3 Did you wish you could use the tags?
- Yes (1)
- No (2)

If Yes Is Selected, Then Skip To Which ones did you wish you could use? If No Is Selected, Then Skip To Why not?

Q4 Which ones did you wish you could use?
- Facebook page (1)
- My email (perhaps linking to someone else's email) (2)
- Book renew (3)
- New books (4)
- Mobile Catalog (5)
- Stacks Map (6)
- SILS brochures (7)

If Which ones did you wish you... Is Greater Than or Equal to 0, Then Skip To Finally, do you have any recommendati... If Which ones did you wish you... Is Equal to 1, Then Skip To Of the ones you used, rank them in or... If Which ones did you wish you... Is Equal to 0, Then Skip To Explain briefly why you did not use a...

Q5 Why not?
If Why not? Is Not Empty, Then Skip To Finally, do you have any recommendati...

Q6 Check all the tags that you used. If you didn't use any, please click next.
- Facebook page (1)
- My email (2)
- Book Renew (3)
- New Books (4)
- Mobile Catalog (5)
- Stacks Map (6)
- SILS Brochures (7)

If Check all the tags that you... Is Greater Than or Equal to 2, Then Skip To Of the ones you used, rank them in or... If Check all the tags that you... Is Equal to 1, Then Skip To Describe your experience using the NF... If Check all the tags that you... Is Equal to 0, Then Skip To Explain briefly why you did not use a...

Q7 Explain briefly why you did not use any of the tags:
If Please explain briefly why ... Is Not Empty, Then Skip To Finally, do you have any recommendati...
Q8 Of the ones you used, rank them in order of usefulness (drag and drop):
   ______ Facebook page (1)
   ______ My email (2)
   ______ Book Renew (3)
   ______ New Books (4)
   ______ Mobile Catalog (5)
   ______ Stacks Map (6)
   ______ SILS Brochures (7)

Q9 Describe your experience using the NFC tags (ease of use, usefulness, etc.)

Q10 Finally, do you have any recommendations for future implementations of
    NFC in the SILS library, such as specific functions or placement?

1.3.3 Discussion

Qualtrics (www.qualtrics.com), a survey tool that allows for a wide range of
questions and complex logic, was used for the post-survey. Taking full advantage of its
complex logic functions, an intricate survey where each answer resulted in a different
question was made. While the result of the survey itself seemed complex, the respondents
would only see around three or four questions resulting in what should be an easy survey.

It was also noted and specified in the email that anyone could participate in the
survey, regardless of owning an NFC enabled device or whether they did or didn’t use the
tags. The reasoning for this is that really any response could benefit the experiment,
especially if it were to remain in the SILS library. The SILS library could perhaps find
some way of fulfilling the functionality the users the might have otherwise not had by not
being able to use the tags.

The purpose of this survey was to get at whether anyone actually used the tags,
what they thought of it if they did, and why they didn’t if they didn’t. For those who do
not own NFC enabled devices, they were asked whether they wished they could have
used the tags. If they answered yes, they could pick which tags they wished they could have used, and if they answered no, they would then be asked why not. Knowing which tags they wished they could have used provides valuable information so that those tags, alongside with the ones that were used, could be made more evident in the library or be placed in more than one location.

As for those who do have an NFC enabled device, if they did not use the tags, they would be asked why not. If they did use the tags they would be asked to select the ones they used, then depending on whether they used two or more, to rank them in order of usefulness, and to describe the experience with the tags. Finally, all respondents, regardless of answers, were asked if they had any final thoughts or recommendations for future implementations of NFC tags in the library.

Results

1.1 Pre-survey\(^2\)

The pre-survey had 51 total responses. As will be seen later, the response rate for the post-survey, my only guess for such a high turnout was that there was legitimate interest in this project or that people really didn’t know what NFC was and thought that they would find out, meaning they were curious. Either reason still resulted in a good start to the experiment.

\(^2\) For the full list of responses, see Appendix A
1.1.1 Q1 – What brand of smartphone do you own

<table>
<thead>
<tr>
<th>Device owned</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>iPhone</td>
<td>21</td>
</tr>
<tr>
<td>Android</td>
<td>19</td>
</tr>
<tr>
<td>Windows Phone</td>
<td>2</td>
</tr>
<tr>
<td>Blackberry</td>
<td>0</td>
</tr>
<tr>
<td>No smartphone</td>
<td>9</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
</tr>
</tbody>
</table>

In another surprise, it turns out that there is a good balance of those who own NFC enabled devices and those who do not. It was predicted that the school was going to have much more iPhone owners than anything else, just due to its sheer popularity. It is also important to note that nine people do not own smartphones. They most likely have never heard of the technology, and have most likely never used QR codes either. It is a bit of a shame that so many people, due to whatever circumstance, do not have smartphones in this day and age where everyone is always connected. Maybe they don’t want to always be connected, they have no need for one, can’t afford it, or any other reason. But that is a conversation for another paper.
1.1.2 Q2 – Is your device NFC enabled?

This question's purpose was two-fold: 1) to reaffirm the number of NFC enabled device owners given by the previous question and 2) to allow the students to see for themselves whether their device is NFC enabled or not, either by checking the link, or finding the inceptive to research more about their phone and all its capabilities.
1.1.3 Q3 – Have you ever used NFC?

Since about 12 people skipped this question, it could be assumed that those who skipped it were ones who answered “no” to owning an NFC enabled device and so would have answered “no” to this question as well. Four is a reasonable result of those who said “yes”, showing that just a small number of people have already experienced what it is to use NFC technology.

There were some responses that basically stated that they have no interest in using the technology. Some quotes are “I’ve never felt the need to do so,” “not really interested in doing so,” “never had a reason to” and “no need for it?” stated as a question. Besides that, the overwhelming response to this question was that people just do not know what this technology is, though this was somewhat expected as was stated in the limitations section. As such, properly educating an entire population on a new technology, that a lot
of people stated are frankly not interested in, is definitely the biggest hurdle in implementing NFC tags in the SILS library.

Since every single SILS student needed to be contacted, and perhaps not everyone would have time or probably not have enough interest in having small group lessons on how to use the technology, email was the best solution for the given situation. Depending on interest, they could skim it and be mildly aware of the technology, or read it carefully and try to understand it, or possibly read it and go on to further research the technology and perhaps even go so far as to try to implement it in their own homes and daily lives, as apparently at least one person did prior to this study.

That person that mentioned using NFC tags in their home uses it for the same purpose as this experiment: to open links. The other people who also previously used NFC tags used it to share images and for social networking and all stated that they had fun doing it. It should also be noted here that one user stated that NFC is “easy after overcoming a learning curve” and that another rated its difficulty as “low to moderate.” This is still part of the teaching obstacle that has to be overcome in the future for this technology to become completely viable.
1.1.4 Q4 - Have you ever used QR codes?

As QR codes can be found just about anywhere, such as on advertisements in the mail, on posters, and have been around for quite a bit, it was expected that quite a few number of people would have used them or at least seen them at some point in the past. A lot of the responses reported having used QR codes in exactly those situations. The majority of the people stated QR codes as being easy to use, but a handful of people stated that they were difficult or obnoxious to use.
1.1.5  Q5- How often do you visit the SILS library? (NFC owners)

How often NFC owners visit the SILS library

- All the time: 1
- A few times a week: 8
- A few times a month: 7
- A few times a semester: 4

1.1.6  Q6 - How often do you visit the SILS library? (Non-NFC owners)

How often non NFC owners visit the SILS library

- All the time: 7
- A few times a week: 12
- A few times a month: 7
- A few times a semester: 5
Comparing the responses of the frequency of students who own NFC enabled devices that frequent the SILS library to that of those do not own them, there are two things to note. First, the pattern for library attendance is generally the same, with a few visiting all the time, a lot visiting a few times a week, and a decreasing number visiting a few times a month and a few times a semester. Second, it was curious to find that those who do not own NFC enabled devices frequent the library more often (all the time) than those who do own NFC enabled devices. So far the results show that the school is split about 50/50 in terms of iPhone vs Android/Windows phone users and that regardless of device, everyone frequents the library in generally the same pattern.

1.2 Post-survey\(^3\)

Compared to the pre-surveys high turnout of 51 responses, the post-survey had a moderate turnout of 14 responses. Either the email containing the post-survey was sent out at a time when everyone else was busy with other work, or interest (or lack thereof by the unanimous results from the previous survey of knowing what NFC is) simply started to fade away at this point.

\(^3\) For the full list of responses, see Appendix B
1.2.1 Q1 – Do you own an NFC enabled device?

![Own an NFC enabled device?](chart)

The purpose of this question was so that the logic of the survey would point the users to their appropriate question.

1.2.2 Q2 - Did you wish you could use the tags? (in response to not owning an NFC enabled device)

![Wish you could use the tags?](chart)
This was actually surprising to find out, since it did not seem that anyone from the pre-survey that said “no” to owning an NFC enabled device showed any interest in being able to use the tags or have anything to do with the technology.

1.2.3 Q3 - Which ones did you wish you could use? (in response to wishing they could use the tags)

Both people that wanted to use the tags wanted access to the mobile catalog. The appeal to the tag accessing the mobile catalog is that it could be tapped in passing while walking to into the stacks, making it convenient to search for a book and be able to find the call number and find it easily. The other three they wanted to use were the Facebook page, the book renew and, interestingly enough, my email (though of course they could have meant for it to link to someone else’s email.) That tag linking to someone’s email, for example, could be used at the front desk, so if someone needs to contact someone
who is out, they can simply tap the tag and send them an email. It could even go so far as to whoever would consent to having their phone number programmed into the tag, have the tag send a text message to that person. A use for this is that the person at the front desk is out in the stacks and someone shows up to the front desk with a question. They simply tap the tag to send them a text message, notifying them that someone is there.

1.2.4 Q4 - Why not? (in response to not wanting to use any of the tags)

There were two rather harsh/eye opening responses for this survey:

1. I have never used NFC tags before, and I could easily find those sites using my phone's browser/a Google search. The tags might be more useful to people who are unfamiliar with the library and related online resources.

2. I am confident in my ability to find the information I need without them. I have never had a smart phone, and I feel no lack of information because of it.

Both responses basically say that they have no need for the tags, saying that they can easily find the information that the tags provide for them on their own. What can be inferred from this is that they would appreciate it if the tags did something more complex, something they could not easily “Google”. With that, the tags would not just be a link, but a shortcut for a more complicated set of commands rather than just navigating to a webpage. The other two responses stated they still did not know what this technology is, meaning they were people who obviously did not see the email that was sent out with the tag locations and instructions.
1.2.5 Q5 - Check all the tags you used (in response to owning an NFC enabled device)

Unfortunately, the only tag that was actually noted as being used was the one that brought up the SILS map, and it was used once. Questions 6 – 7 were not answered.

1.2.6 Q8 – Describe your experience using the tags (in response to having used the tags)

One person noted that they “tried to use multiple nfc tags. I couldn't make them work with my phone (It is NFC enabled, I have used other NFC tags).” It is not possible to know the extent to which this person was unable to get the apps to function. Since they say they have used NFC tags before, it could be safely ruled that it was not a matter of them not knowing how to use the tags. The only other possible explanation is that the NFC tags were not compatible with their device. This is a highly unfortunate result, since the tags that were picked were stated as being widely compatible with all NFC enabled devices and were tested with two completely different devices.

1.2.7 Q9 – Final recommendations (all respondents)

Perhaps the harshest user comment of all was “too user hostile”. The email instructions really tried to have the NFC tags come across as easy and fun to use, but apparently at least one person thought the exact opposite.
Future work

Based on the final results, there are a few recommendations to be made for any future work in this area.

First, tags must be carefully researched with heavy detail paid to which devices they work with. A variety of different tags must be tried with as many different devices as possible to make sure that the tags that will be used work with as many devices as possible.

Second, besides having the tags that provide links to webpages, some tags should also be developed that provide more complex tasks. What exactly those tasks would be is unknown. Finding out might involve sending out more surveys and asking SILS students what tasks in the SILS library they wish could be made easier that take place on the website or even outside the website.

One person in the survey suggested using low-powered Bluetooth as a replacement for NFC since all devices, including iPhone, could use low-powered Bluetooth. Unfortunately for their recommendation, the point of this project was to use NFC specifically knowing full well that a lot of students would not have NFC enabled devices.

Finally, another limit to this study was lack of knowledge on the users end. Perhaps workshops could take place that showcase emerging technologies, including NFC, and how to use them. Email alone will not suffice, seeing as many people missed the email entirely for this experiment.
Conclusion

To summarize the entire experiment, NFC tags were placed around the SILS library and were evaluated based on usage and usefulness by sending surveys to the SILS student body. The pre-survey had a response rate of 51 and reaffirmed the fact that NFC is not that popular and so requires a bit of work when it comes to informing people how to use the technology and how it can benefit them. The post-survey had a moderate response rate of 14 and responses in the form of not many people having used it. While two people clearly stated that they have no use for the technology in its current state because of the confidence they have in their own abilities to find the information, there were two other people who truly wished they could have used the tags. It was stated earlier that it could be argued that if even a few people benefited from the technology that it would have its place, and this is the perfect example of why the NFC tags should remain in the SILS library.

The great thing about NFC tags, and QR codes for that matter, is that they do not stick out and are only “there” if you choose to pay attention to them. They are noticeable, but do not get in the way. One could pass by a tag and easily choose to ignore it, or make full use of its capabilities by, for example, quickly tapping the tag on the way out of the building to check if SILS has posted any photos to their Facebook page. What is even better about NFC is its lack of requiring an extra app and the greater functionality it provides over QR codes. QR codes require the user to be stationary, while NFC tags can be read by simply tapping it in passing, an interaction that should take no more than two seconds. QR codes can only send links to web pages while NFC tags can be programmed to send messages, email, change phone settings and more.
As it stands, QR codes and NFC can easily stand side-by-side and be available for people to choose which way they prefer to get their information. If Apple decides to implement NFC in their phones, there is a high chance that the adoption rate for this technology will increase, developers will begin to think of creative ways to use these tags and it will eventually become a part of everyone’s day to day lives.
Bibliography


CNET. "How to Program Your Own NFC Chips." YouTube, 10 July 2012. Web. https://www.youtube.com/watch?v=td_O6m6zDLo


Appendix A – Pre-Survey responses

1.1 Q3 - Have you used NFC? - Yes

- I have used it in the realm of social networking, but mainly as an experiment, never really in my day-to-day life. I found the experience to be easy after overcoming a learning curve.
- Yes, setting alarms and accessing email/websites in the morning - Low to Moderate difficulty, quite fun.
- Yes. I use it often to share photos, webpages and other items via Google's "Beam" NFC application. I think it's really easy to use and gets users interacting with the application and other users in a novel, fun way.
- I have shared a few pictures with other Samsung Galaxy users. It was simple and fun.

1.2 Q3 - Have you used NFC? – No

- No. Don’t know about them.
- I don’t even know what it is!
- I don’t know what it is.
- I have never owned an NFC-enabled phone.
- Not sure what they are
- I’ve never felt the need to do so.
- Didn’t know what it is
- I have no idea what this is
- Never seen them, leaving NFC on drains battery.
- Never heard of it
- No. Not really interested in doing so.
- Don’t know about this feature
- Never see them, no reason to
- It isn’t available on my phone
Don’t have NFC
I don’t even know what NFC is.
No smart phone
Never had a reason to
No, I don’t know what it is or what it does.
My phone is not on the list, but my old phone did have NFC and I used it once. It was cool, and easy to use.
Don’t have a smart phone
Never heard of it
I don’t know how to use it.
I don’t know what it is, haven’t had a reason to figure it out
Don’t know what they are
No need for it?
I have no idea what NFC does. Also, I have a new smartphone and don’t know all of its capabilities yet.
Haven’t had the occasion to do so.
My phone doesn’t have NFC, and when I had an Android phone I didn’t know about NFC

1.3 Q4 - Have you used QR codes? - Yes

Yes. I have them on my business cards.
I think it is a nice idea.
I rarely use them and would usually prefer to have a URL that I can type in.
Side note: since a bunch of students have iPhones, consider using low-power Bluetooth, if possible, to avoid missing out a large portion of the population without NFC-enabled phones.
Yes, promotional junk on a flyer or package. Not useful (just ad junk), not very enjoyable, they feel more of a hassle to me personally.
• Rarely; I've used them at the NC Museum of History, though, and it was informative and fun--linked me to video and more information in the Watergate exhibit.
• I've used it when it is in magazines etc
• Yes, I have used QR codes for commerce abroad and more experimentally when logging on to websites.
• They exist, Google goggle makes it very easy.
• Yes - used them in conferences, to link to websites, etc. - thought it was easy and a good idea
• For coupons, easy but annoying
• Yes, briefly, enjoyable and easy.
• Downloaded app, scanned
• Sometimes. It's a pretty easy process.
• Yes, generated one for a flyer. Thought it was fun.
• Yes, but I don't like that I need a separate app to read them. I wish this functionality were integrated into the OS.
• Yes, for getting information from a mfg. or company. Fairly easy if you know what you are doing.
• Yes. Price comparisons, ISBN lookups, curiosity about ad campaigns that used them. Easy enough to use, though these seldom led to information that I found very useful.
• Yes, used it for Bull City Bucks. Simple to use.
• Once on a sign somewhere but it was too complicated
• Yes, I have used them to access mobile websites and applications. It is fun, but sometimes a hassle.
• Yes, it was fine. Not difficult but can be hard if you have a slower phone
• Usually to go to a link from a print advertisement. Pretty easy
• Yes, to get more information from a poster. I found it cumbersome and obnoxious, and think short URLs are more effective.
• Yes I've used them. They are mildly interesting information sources, typically
• I use them in commercial settings, and I find them very easy to use.
• For linking to URLs.
• Yes, I have used QR codes on posters/ads and in a recent exhibit at Wilson Library.

### 1.4 Q4 - Have you ever used QR codes? No

• No, I don't know how and have never really wanted to. Why bother when you can just google whatever the thing is? Wouldn't I have to download a QR code app? I also usually move forward in the tech world when people I know show me new innovations and how they could be useful to me, and no one I know uses QR.
• I don't know what QR codes are.
• It usually seems just as easy to use Google to find websites.
• Don't understand them.
• I don't have a smartphone.
• No. Not really interested in doing so.
• Don't want the extra code reader app on my phone.
• No, never appealed to me.
• Always worried about hacking.
• No. I've seen them around but I don't know what they're for.
• No smartphone.
• No, I'm not sure how to use them or if I can without the internet.
• Don't have a smartphone.
• Too much trouble to download the app and everything.
• I don't understand how to make your phone read them.
• Don't find the feature useful in my everyday life.
• They seem annoying.
Appendix B – Post-survey responses

1.1 Q4 - Why not? (in response to why they did not use the tags)

- I have never used NFC tags before, and I could easily find those sites using my phone's browser/a Google search. The tags might be more useful to people who are unfamiliar with the library and related online resources.
- I am confident in my ability to find the information I need without them. I have never had a smart phone, and I feel no lack of information because of it.
- I didn't even know they existed and have no idea what they are or what they're for.
- I don't know what these are.

1.2 Q8 - Describe your experience using the NFC tags

Unfortunately, due to some logic error in Qualtrics, some people saw this question when they were not supposed to, resulting in questionable answers.

- I didn't use them, so I have nothing to contribute.
- I did not really see them. I only remember seeing one. Also, my phone is an Android but too old for the NFC tags :(.
- I tried to use multiple nfc tags. I couldn't make them work with my phone (It is NFC enabled, I have used other NFC tags)
- I've not used NFC tags.

1.3 Q9 – Do you have any future recommendations?

- No because I don't understand what NFC is.
- I do not.
- I never saw the notices
- None
- Too user hostile
Appendix C – All tools used

- NFC enabled devices
  - Samsung Galaxy SIII
  - Asus Google Nexus 7

- Tags
  - WhizTags NTAG203 Mifare tags

- Survey Tools
  - Surveymonkey.com (pre-survey)
  - Qualtrics.com (through UNC) (post-survey)

- Apps
  - NFC Smart Q - Qnsolv
  - NFC TagWriter by NXP – NXP Semiconductors
  - NFC Writer by Tagstand –Egomotion Corp
  - Trigger – Egomotion corp