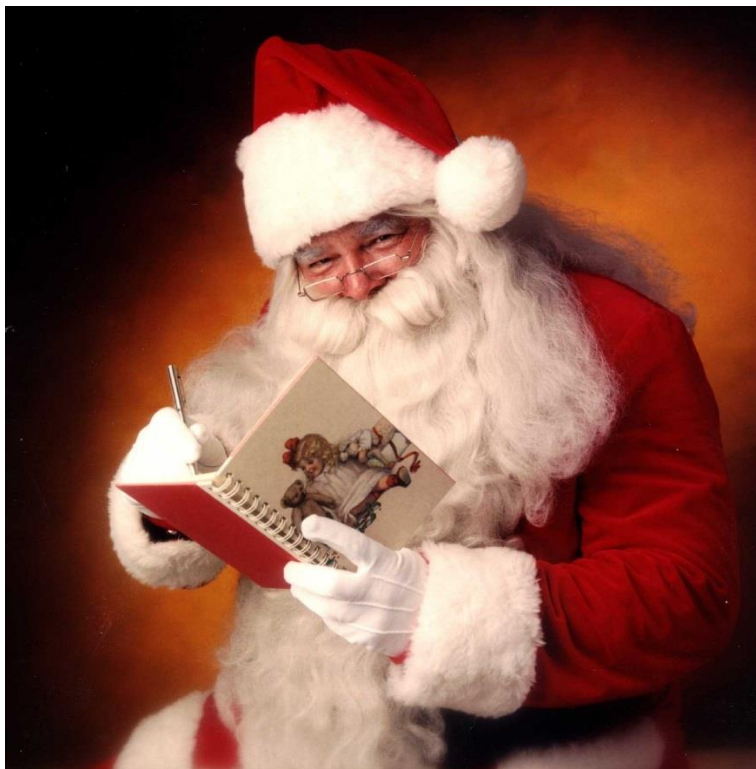# Santa's Residence

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Santa's Residence

ESD.051 Final Project

Executive Summary

Santa's Residence is a calling system meant to enhance the holiday experience for families all around the world. Parents are often faced with a dilemma of purchasing gifts for their children, but have to figure out a way to do so without their children ever doubting the existence of Santa. Parents are limited in their options on how to extract wish lists from their kids without being too direct. They could have their child write out a wish list and put it somewhere, but that gets boring and old very fast. They can also take their kids to the mall and sit in Santa's lap. However, how often do parents go up to the Santa and ask them what their kid asked for, and how does Santa remember? The best method for extracting a wish list from a child should involve a certain level of personal interaction and fun. Therefore, a fun, interactive Santa phone system that also allows the parent to retrieve their child's gift wish list can be the ultimate solution to alleviate headaches during the holiday season.

How does it work?

Our system is designed for parents and their children. The system requires that a parent first call the system to initiate a separate call that interacts with their child. When parents first call in, they are given an overview of the system and instructions on how to use it. Next, the system requires that the parent hang up, call the system again and then hand off the phone to the child. The caller ID is detected and the child is then able to talk directly to Santa to tell him gift wishes. Once the call is done, the parent can call into the same number and say a secret password, "Rudolph," to access a system in which they can hear all the gift wishes their child said.

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1. Motivation

During our brainstorming session, we looked into different possible applications of a voice system. Where is verbal interaction crucial? Where can it not be substituted by a different means of communication, such as writing? How can we provide the user with a unique experience that isn't readily available through their iPhone or computer? We realized that since the holiday season is coming up, it would be unique to make a phone system that could allow kids to record their gifts and then give parents access to those responses.

2. Vision

Our vision was simple -- to make the conversation with Santa as realistic as possible. In order to solve this, we had to ask the question:

What characterizes a real person, and Santa in particular?

- Genuine tone of voice

  We had to make sure that Santa sounds genuine and enthusiastic. We looked for a voice actor that could sound just like Santa with the minimal amount of audio editing. We recorded our prompts multiple times to make sure they were genuine and realistic, closely directing the voice actor to ensure that his tone of voice matches the mood the system attempts to convey.

- No repeated prompts

  A real person doesn't ever repeat the exact same thing in the exact same way, without any changes in at least the pace, tone of voice, or level of loudness. We decided to make it our priority to have sufficiently many prompts between which we can randomly choose, so that there never is encounter a situation in which a caller hears the same prompt twice.

- Realistic background sounds

  We wanted to make the call experience feel warm and welcoming, just as if caller is sitting right next to Santa. We ensured included background noises in the calls: flipping pages, when Santa is looking through his naughty and nice book; Miss Claus, calling Santa for dinner when he needs to end the call; the sound of an object hitting the table, when Santa drops the phone and asks the caller to repeat his/her wish.

- Resilience to invalid or unrecognized inputs

  In order to make using the system feel like talking to a real person, we had to ensure that unrecognized answers were handled smoothly and gracefully. This need was augmented by the fact that children often speak quite differently than adults, both in terms of vocabulary and enunciation -- the saying "kids say the darndest things" comes to mind. Through some clever prompt-writing and unconventional use of the Angel platform, our final prototype is able to have a meaningful interaction with a child even in cases where it cannot understand a single word that the child says.

We also wanted to ensure that the system was meaningful to parents, giving them easy access to their child's wishes without diminishing the "Santa experience" for the child. We wanted to solve two central issues:

- Allowing the parent to easily access a parent menu that is hidden from the child

  Nothing would break the magic of speaking to Santa faster than a prompt that says "Please say 'parent' to access the parent menu," so we obviously wanted to hide the parent functionality away from the child while still making it easily accessible. Our final prototype uses a password-style answer to a seemingly innocuous question at the start of a call.

- Service discovery and use

  We could not depend on parents having any information about our system (apart from the phone number) before calling it for the first time. However, as we had decided to use a password to access the parent functionality, we had to ensure that the password was something the parents could remember easily and discover through the system without outside help. The way our final prototype solves this problem is by explaining the way the system should be used to callers from a number that has not called before. The system will repeat the innocuous set-up and the password multiple times during different stages of the initial call, and the password itself is Santa-themed ("Rudolph") to make it easier to remember.

The following subsections contain several K-scripts that illustrate the feel of our system we wished to achieve. The K-scripts also reflect a possible series of interactions with our final prototype.

2.1. K-scripts – First Parent Call

Who	Script	Notes
Santa	'Santa's Residence', Santa speaking. 'Santa's Residence' is a phone system designed with your child in mind. Once you enable the system, your child will be able to call me, Santa, at the North Pole! I will ask about the gifts on his or her Christmas list this year and save them in our toy factory database. After your child has told me what he or she wants, you can access this wish list by calling back. When I ask 'Who is calling me?' at the beginning of future calls, if you say the password 'Rudolph', you will be taken to a menu in which you can hear what your child has asked for. If you want me to repeat the instructions, say 'repeat'. If you are ready to enable calling Santa for your child, say 'done'.	The introduction gives the instructions on how to use the system and how to access the secret parent menu.
Parent	Done.	
Santa	Fantastic! The next time that "Santa's Residence" is called, I will automatically answer to speak with your child. I look forward to hearing what he or she wants for Christmas! Thank you for calling "Santa's Residence"! Merry Christmas!	Gives further clarification about the system.

2.2. K-script – Child Call

Who	Script	Notes
Santa	Ho Ho Ho! Merry Christmas! You have reached the North Pole! This is Santa speaking! Who may I ask is calling my arctic toy factory?	Introduction to child call. It asks the name to feel more real to the child, and offer the parent a chance to say the password "Rudolph."
Child	Alex.	
Santa	Why hello! Have you been good this year?	This is also a message prompt that does not listen for any response.
Child	Yes!	
Santa	Let me check my Naughty and Nice book! < pages flipping > Ah! Here we go! It looks like you are on the nice list this year! Well, you know what the kids on the nice list get for Christmas?	This message is also another prompt that does not require any response, but rather tries to establish a Santa character.
Child	Toys!	
Santa	I try to give them a special toy or gift that makes them very happy! It's a very busy time of year right now, but I would love to hear a few of the gifts on your Christmas list! What is the one gift that you want most for Christmas?	Asks for the first gift, what the child wants most.

Child	Umm … a puppy!	If the response is a recognizable gift, the system will play programmed messages.
Santa	A puppy?! I might have to talk to your parents about that first! They're a lot of work, but so cute!	
Santa	Do you have another gift that you would like for Christmas?	Asks for the second gift.
Child	Legos!	Also a recognizable gift by the system.
Santa	The elves love building too! Sometimes I think there are more Legos in our house than there is snow on entire the North Pole!	Response to child's request for legos.
Santa	Ooh! I can smell Mrs. Claus's dinner! You know, Santa needs to eat up before his big night! I must go soon for dinner, but is there one last gift that you would like me to put on your list?	We wanted to limit the amount of gifts the child would input into the system to 3, so the last prompt is like an "excuse" for Santa to leave.
Child	Xbox!	
Santa	That sounds great! Maybe I can convince the elves to add a game to that Xbox, so that you can test it out right away!	

Santa	Well my dear child, thank you so much for calling me up here at the North Pole and sharing your Christmas gift list with me! I'll send your wishes directly to the elves in the toy factory! In the meantime, make sure that you are really good, because I'll be checking my list…and checking it twice! The reindeer are excited to visit your rooftop soon - maybe you could leave some carrots out for them on Christmas Eve! Goodbye! Merry Christmas!	Santa gives a goodbye response.

2.3. K-script – Parent Menu

Who	Script	Notes
Santa	Santa's Residence. This is Santa! Would you like to access your child's Christmas wish list for Santa or would you like me to help you use the system? Please say either 'wish list' or 'help'.	After the answers the "Who is calling me" prompt by saying "Rudolph," they are taken to this menu. They can access the gift wishes here.
Parent	Wish list.	
Santa	Okay, I will read your child's wish list back to you one item at a time. After each item, you can say 'repeat it' to hear it again, or 'continue' to move on to the next item. Oh, and if I was unable to understand what your child asked for, I will play back a recording of what he or she said.	The system now plays back either the recorded gift wishes or automated responses depending on whether the gift was recognized.
Santa	The first wish was a puppy. Do you want me to repeat it or continue?	
Parent	Continue.	
Santa	The next wish is Legos. Do you want me to repeat it or continue?	
Parent	Continue.	

Santa	The next wish is an Xbox. That was the last item on your child's wish list. If you would like to hear the list again, say 'repeat it'. If you would like to delete the list, say 'delete it'. Otherwise, please say 'I'm done'.	The system gives the option to either repeat or delete the wishes. If the parent deletes the wishes, the system will clear the slate for the next call.
Parent	I'm done.	Terminate call
Santa	All right. Thank you for calling Santa's Residence! Merry Christmas!	

3. Design Process

To create our system, we used a 10-step design process that takes into consideration who the primary users are, what their needs are, and whether the final product satisfies those needs. We will present a brief discussion of each step of our design process.

Step One – Identify Needs

As the holiday season approaches, kids are trying to make sure that Santa knows exactly what they want for Christmas. Parents, on the other hand, want to make sure that their children receive gifts that they want and that all of their wishes from Santa are granted to keep the Christmas cheer and imagination flowing. A phone system in which a child can call and interact with Santa or his elves will provide the perfect holiday-themed activity that not only satisfies the child's wish to tell Santa what he or she wants for Christmas, but also provides a list for the parent to review later.

Step Two – Information Phase

A child can always go to the mall and interact with Santa in person, but Santa is also seeing so many other kids, that he may not remember exactly what one particular child wants. A child would be very satisfied knowing that a personal phone call to the North Pole will ensure that Santa will send his or her favorite gift directly to the toy shop! There are other ways of communicating with Santa other than in person, such as letters, but a phone system gives a personal touch since there is direct feedback from the big man himself. Our team found an existing voicemail system in which the child just leaves a message for Santa, but this phone system would go beyond it and provide interaction with the child rather than just a recorded voicemail. Not only is it an exciting experience for a child to speak to Santa on the phone, but it contributes to the magic of Christmas and keeps kids' imaginations engaged for much longer!

Step Three – Stakeholder Phase

The children of the world who celebrate Christmas are those who would be most interested in this phone system, as it would be their direct link to Santa Claus at the North Pole. The parents of these children would also have a stake in the system because it can help with their Christmas shopping for their child. Other potential stakeholders include the other forms of Santa that exist, such as mall Santas, photo booth Santas, and the letters that are sent to Santa.

Step Four – Planning and Operational Research

There are many features that would be ideal for a system like this. A child isn't going to believe that they are actually talking to Santa Claus if there are any text-to-speech prompts or a voice that simply doesn't sound like Santa. Personalization is important, so for the scope of this project we decided the system should have a list of common gifts that are pre-loaded into the system, so that it can respond to gift requests with responses tailored to each gift individually. Researching the capabilities of the Angel platform showed that it was not possible to both record and recognize the child's voice at the same time, but we felt that we could work around this problem with some creative prompt-writing. We believed it should be possible to leave out the personalization factor and reply with a general response when the gift was not recognized by the system, while at the same time asking the child to repeat his or her wish so that Angel can make a recording for future playback. Our system's belief factor would also be constrained by Angel's bad audio quality as well as the quality of voice acting that we can find. Because the system is designed for both children and parents, two distinct sections of the system need to exist, and the distinction between the two must be subtle such that a child cannot accidentally access the parent portion and find out the inner workings of the system, breaking the magic behind the system in the process. We were also constrained by the problem of service discovery -- we couldn't expect parents who have never used this system before to know a secret password to access the parent portion of the system, so we knew we had to come up with a creative solution to this problem.

Step Five – Hazard Analysis

Creating Santa's Residence was very risky in multiple respects. The most significant risk was that the system would not be sufficiently convincing, leaving children convinced that Santa doesn't exist. Because children are the primary stakeholders that we want to please by creating this system, it needs to be tailored to be usable by a young child. We noted that children often speak differently than adults, both in regards to jargon and enunciation, and it was unclear whether or not Angel would be able to reliably understand what a child is saying. We decided to mitigate this risk by ensuring the system would still work for the child even if Angel is unable to understand any of the words and is merely able to determine whether or not the child is speaking at all. This was implemented by, for example, making many of the questions that Santa asks not actually listen for any particular response. Instead, they are intentionally phrased in a way that can be seen as rhetorical -- ensuring that the interaction between the child and Santa sounds reasonable whether or not the child chooses to respond.

An even more tricky situation arises when Santa is unable to understand the child's wish. Since we cannot possibly have a comprehensive list of all presents kids could ask for, and we cannot even count on always recognizing what the child is saying, we decided to mitigate this risk by having a dual strategy for saving

gifts. The system should first attempt to recognize the child's wish and if it succeeds, it should play a response prompt customized to that wish. However, if the system fails to recognize the wish, it should come up with a light-hearted, humorous excuse for why the child needs to repeat the wish, and then record the child's voice. To deal with cases where multiple wishes are not recognized in a sequence, we decided that our system should randomize the excuse prompt and the generic wish response prompt it plays whenever a wish is not recognized.

Step Six – Specifications

Our primary specifications before drafting a design was that the system was to be designed to cater towards children and portray the sensation of speaking to Santa Claus. Believability and simplicity were very important when creating the K-scripts, as described in Section 2. The tone would have to be conversational, but still get the child to say what the system wants to hear.

The setup of the system was determined to be a phone system that allows a child to tell Santa what gifts he or she wants for Christmas and then for a parent to be able to access a list of what his or her child asked for. This method created the specification that the system must have two parts: one that interacts with the child and one that interacts with the parent.

Step Seven – Creative Design

All four members of our team presented their own versions of the K-script for the system before discussing the specific details of the system. This process was to maximize the amount of creativity and personal input from each person. There were several different ideas. One idea was to have a system in which an elf takes a message to leave for Santa; another was an introduction by an elf who passes the phone off to Santa for the discussion of gifts. The final option was a system in which Santa speaks the entire time.

In regards to the parental interaction, some options were to have an elf address the parent or Santa himself. It was primarily agreed upon that the parent menu should be concise and quickly provide the parent with the information that he or she desires: the child's Christmas gift list. There were a lot of different ideas for ways to transfer to the parent menu. If Angel was capable, a phone extension on the phone number could lead to the parent menu, or a secret password.

The child-Santa interaction is the primary interaction and the main focus of the design. The believability is important as well as the child's interpretation of Santa's interaction with him or her. Several unique ideas were brought to the table. One system idea involved unique personalization for each child that

called, addressing by name if the name was stored in a database and recognized. Another idea allowed the child to ask simple questions about Santa Claus to an elf. One let the child not only leave a gift list for Santa, but also a short message. Some of the ideas involved unique responses to certain gifts that are stored in a database. Thus, it would making it seem more realistic if Santa actually responds to the gift name that was spoken.

This brainstorming of ideas led to a set of very creative design options.

Step Eight – Conceptual Design

Combining all of the potential systems that the four teammates brought together led to the decision on a conceptual design that incorporated aspects of each teammate's K-Script. It was determined that Santa would complete all of the interactions, as long as a good Santa voice talent could be cast. The parent system would be accessed via a password "Rudolph" in order to fit the Christmas and Santa theme. In order to ensure that the system would be fully operational, undependable features such as name personalization and allowing for free-form questions from the child were avoided.

The first time that the system is called, Santa will answer the phone and speak to the parent, giving instructions on how the system works and how the parent can access their child's wish list after the child calls using the password system. The parent is then asked if they are prepared to enable the system for their child to call.

Once the system is enabled, all future calls will lead to Santa's greeting for a child. Santa will ask for the child's name and if he or she has been good this year. To add to the realism, the child even can hear Santa flipping through the pages of a book before informing him or her that he or she is on the good list this year. Santa then proceeds to ask for three gifts. There is a database in Angel of several gifts that have unique responses to them. If the gift does not happen to be on this list or if the gift is not understood, Santa will provide a randomized excuse as to why he did not hear what was just said and ask to repeat. Angel will then record what the child says, for storage in the system when the parent replays the gift list. Unique no-input responses were also developed to encourage a child to enter a gift. On the third no-input in a row, Santa will inform the child that he has another caller on the line and must leave, thus ending the call. This feature was created in case a child is unresponsive or afraid to speak to Santa Claus. After Santa has collected the three wishes, he says a goodbye message but does not hang up for a short period of time, allowing the child to say goodbye and "Merry Christmas!"

Step Nine – Prototype Design

After refinement of the conceptual design through several iterations, a prototype design was implemented in Angel. The team did some internal testing to ensure that the system was functioning properly and that the flow of the call was appropriate and clean. Several voice actors were auditioned for the voice of Santa, and a voice actor with an energized, low pitch voice was cast for the role. Everyone on the team reviewed the initial recordings, including several modified versions that digitally reduced the pitch of the voice by different amounts. Once the audio recordings were edited to perfection, just as the team wanted, they were added into Angel. The team tested the new voice of the system again before performing usability testing.

Step Ten – Verification

The system was verified to work both by performing basic functionality testing internally to the team and by usability tests with eight different subjects. The usability tests revealed useful feedback that people with no prior knowledge of the system had about the system and their perception of how Santa's Residence fulfilled its purpose. Aside from finding several minor quirks that were quickly addressed, the feedback was very positive, so we consider Santa's Residence a success.

3.1. Design Details – Wish-specific Responses

We decided to create a list of a number of customized responses to the gifts that the caller can have on his/her list, as we believe that this makes the interaction more human-like. We felt that generic gift responses – even if randomized – would quickly start sounding fake, so we created customized responses for each gift that the system can recognize.

Gifts	Customized responses
an Xbox	That sounds great! Maybe I can convince the elves to add a game to that Xbox, so that you can test it out right away!
teddy bear	Oh yes! There is nothing quite like a hug from your teddy bear when it's snowing outside!
a doll	A doll … of course. We'll find one just for you!
camera	Taking photos is a really fun! I'll make sure the elves find a nice camera for you!
football	Football is one of my favorite sports! You got it!
phone	A phone, you say? I agree! It's a good thing to have and you'll be able to call the elves any time of day!
iPod	I have an iPod, too! All full of my favorite magical Christmas songs!
puppy	A puppy?! I might have to talk to your parents about that first! They're a lot of work, but so cute!
Legos	The elves love building too! Sometimes I think there are more Legos in our house than there is snow on entire the North Pole!
bike	Biking is the most fun transportation! Of course I can find the perfect bicycle for you!
scooter	I love scooters! If there wasn't so much snow up here in the North Pole, I would scooter everywhere!

3.2.   Design Details – Generic Wish Responses

At the same time, the system could easily face a wish that it could not understand. This is why we created multiple generic responses to wishes, and we chose between them randomly every time. Our aim was that no prompt is ever repeated in the same call, so we made enough of them to make that scenario statistically unlikely.

Here is the set of generic wish responses that we wrote:

- What a great choice! I will send your request to the toy factory!

- Why haven't I thought to put that on my list yet? I like that idea!

- < in agreement > Mmm… I think my elves will have fun with that one!

- Ah yes! I'm writing that down now!

- < cheerfully > Ho ho ho! You have such great taste!

3.3.   Design Details – Unrecognized Wish Excuses

We wanted to ensure that Santa's responses when the system cannot recognize the wish are light-hearted and cheerful, to play down the fact that the child will need to repeat its wish one more time. We wrote a set of North-Pole-themed excuses that we incorporated into our system to make this part fun for the kids. User testing confirmed that instead of getting frustrated because the system wasn't recognizing their input, users thought that the excuses were fun to listen to and made Santa more believable.

Here is the set of unrecognized wish excuses (child menu no match prompts) we used:

- Sorry there, little one! The elves came with a new idea for a gift for Mrs. Claus and I missed what you said. What was it that you wanted?

- Oh, no! My clumsy little elves – marshmallows everywhere. Though the hot chocolate smells delicious. I'm sorry, what was it that you wanted?

- These phones on the North Pole … the service doesn't always work with all the cold! I didn't catch that last wish of yours – what was it again?

- Forgive Papa Frost, but those ears aren't so young anymore. Say that wish one more time?

- Oh no… I think there is a blizzard starting outside. Brrr, so cold! What was that last gift, little one?

- < dropping phone > Clumsy me… Forgive old Papa Frost! What was that last gift on your list?

- That must be something new! I must tell my elves to put it on the special list; can you repeat it so that I make sure they get everything right?

- < to the side > I'm coming!! Mrs. Claus says dinner is ready – wonder what she made today! I think I missed that last gift though, what was it again?

- Did you hear that noise? Reindeers' sneezing is the loudest! They made me miss your last wish – can you say that one again?

- < talking in the background > The elves just came home and they're talking so much! Sorry about that, what did you say?

3.4. Design Details – Wish No Input Prompts

Since we felt that children could be shy and not willing to say their wishes on the phone, we also put in a lot of thought into writing good no input prompts. We designed two unique no input responses for each wish and a common third no input response that says that Santa has to go because there are other children waiting to call. We felt this was a reasonable design since we assumed that the child was either undecided on their gifts or had abandoned the phone by then and would need to call back anyway. Because we made this choice, the third no input response did not need to be randomized.

The set of no input prompts we used is on the next page.

	No input 1	No input 2	No input 3
No Input Response Wish 1	No need to be shy! Go ahead and tell Santa what you want for Christmas!	I may not be as young as I once was, but I know my hearing's not bad. Please tell me your number one gift this year.	I'm sorry, but I have to go – there are other children who are trying to call and tell me their gifts. If you think of anything else, please do call back! I love talking about Christmas presents!
No Input Response Wish 2	There are so many choices! And I would really love to hear what would make you happy to unwrap this Christmas!	It took me a bit to decide what I wanted to on my Christmas list too. If you don't know right now, you can tell me that you're done with your list and give good ol' Santa another call!	I'm sorry, but I have to go – there are other children who are trying to call and tell me their gifts. If you think of anything else, please do call back! I love talking about Christmas presents!
No Input Response Wish 3	Still thinking? If you've run out of wishes, go ahead and let me know that you're done! Otherwise, I would love to hear that next gift that you want Santa to bring for Christmas!	No need to worry if you can't think of anything else right now. You can let me know that you're done making your Christmas list and then you can always call back later!	I'm sorry, but I have to go – there are other children who are trying to call and tell me their gifts. If you think of anything else, please do call back! I love talking about Christmas presents!

4. Implementation Details

One of the critical aspects of this phone system was the believability and authenticity of the "Santa voice". We realized that in order to convince a child that Santa was actually on the phone, the voice needed a certain cheery timbre and old grandpa tone. After playing around with Audacity, we decided that a voice actor would perform the Santa script and then the voice recording would be lowered in pitch in Audacity. After some recording practice with different people, Daniel's friend, Brian Sennett, was chosen as the voice actor. Since he was experienced in running radio shows, his voice talent fit the most with what we wanted for a Santa. The K-script was organized into a detailed Excel file that contained all the page names and prompt names, so that it was very easy for Brian to go through the lines. All of the voice prompts were recorded in one big file and then normalized. The individual prompts were then edited so that the pitch would be reduced by seven steps and exported into separate files. The voice prompts were then implemented in Angel. In the meantime, the K-script was translated into the state diagram on Figure 1, which was used to guide the Angel implementation.

In order to maximize the believability of the system, we also used Angel's capabilities in several unusual ways:

- Designing no input / no match events to be the expected case

  When a child calls Santa's Residence, the first prompt they hear is Santa asking the question "Who is calling my arctic toy factory?" This is actually the password-prompt for the parent portion of the system, hidden in plain sight! If the caller answers the question with "Rudolph" (the name of one of Santa's reindeer), they will then be redirected to the parent menu where they can hear all the wishes made from that phone number. However, the expected case in this situation is that a child is calling the system and that they will either say a name that is not Rudolph or not respond at all. This will trigger a no input or a no match event in Angel, where we have replaced the default behavior of playing a prompt like "I didn't hear you, please say that again." with a redirection to another page that continues the child portion of the call. As the time until a no input event is raised is relatively short and no match events are immediate upon unrecognized input, this design choice allows us to keep the conversation alive and realistic while also ascertaining whether or not the current user knows the password.

- Creating function-like constructs in Angel

  During the operational research phase of our design process, we found that some Angel pages support jumping to a page whose number is specified by a variable. We used this functionality throughout our system to greatly simplify our design by creating higher-level constructs that closely resemble functions in common programming languages.

  For example, we were able to have only a single set of pages that save wishes into the database, even though this set of pages needed to be called from multiple locations and needed to return to multiple different locations based on where it was called from. We were able to do this by saving the desired return location into a variable, transferring to the set of pages that saves to the database, and then directly jumping to the state specified in the return location variable.

  While it would have been possible to achieve the same functionality using logic pages that redirect to the appropriate page based on the value of a variable, this method was far more easily extensible. For example, when we decided to increase the number of randomized wish response prompts, all we needed to do was add the new prompts and increase the upper bound of the randomly generated value. Without this functionality, we would have also had to spend time tweaking several logic pages to achieve the desired result.

- Having two types of wishes stored in the same wish table

  A carefully designed data model allowed us store both recognized and recorded wishes in the same table, by also storing a flag that specifies the type of wish. The clever data model greatly simplified the saving and the retrieval logic, as all of our important data was in one place in a shared representation. This allowed us to fully use Angel's Smart Play capability to play both recorded "voicemail" wishes and our prompts for each of the recognized variables with a very simple setup.
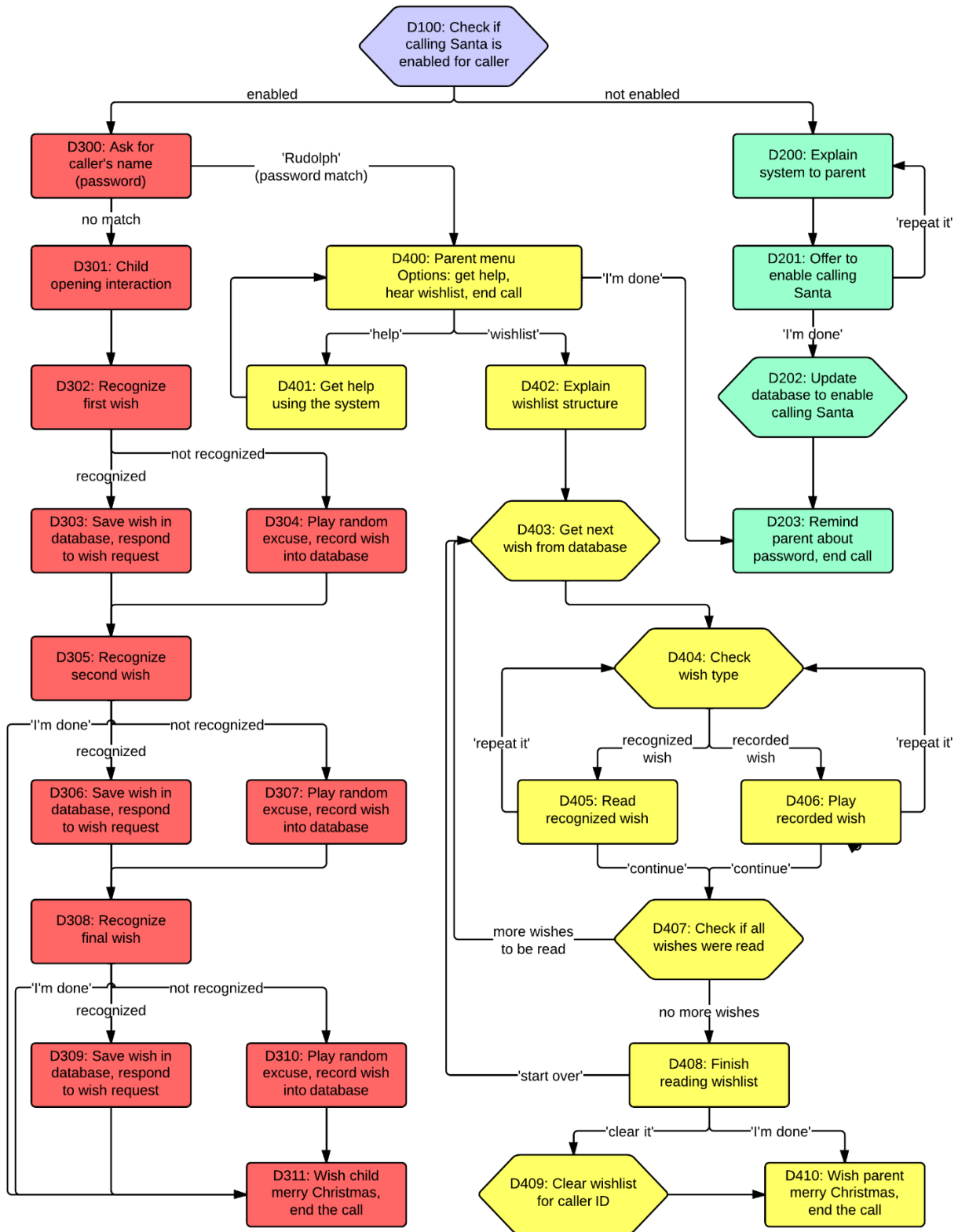
Figure 1 – We used this state diagram to guide our implementation in Angel.

4.1. State Tables – Initial Call Logic (D100)

D100_Check_calling_Santa_enabled

Branch on Condition

Entering from state codes:	Corresponds to Angel state numbers:
none	1000, 1001

Condition	Action
IF calling Santa enabled	Go to D300.
Else	Go to D200.

Other Module Settings / Notes

4.2. State Tables – Parent Intro (D200 – D203)

D200_Explain_system_to_parent

Play Prompt

Entering from state code:	Corresponds to Angel state numbers:
D100	2000, 2005

Prompts		
Condition	Name	Wording
Always	D200_1	'Santa's Residence,' Santa speaking.
	System_help	'Santa's Residence' is a phone system designed with your child in mind. Once you enable the system, your child will be able to call me, Santa, at the North Pole! I will ask about the gifts on his or her Christmas list this year and save them in our toy factory database. After your child has told me what he or she wants, you can access this wish list by calling back. When I ask 'Who is calling me?' at the beginning of future calls, if you say the password 'Rudolph', you will be taken to a menu in which you can hear what your child has asked for.

Condition	Action
Always	Go to D201.

Other Module Settings / Notes

D201_Offer_to_enable_calling_Santa
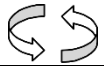
Speech Input

Entering from state codes:	Corresponds to Angel state numbers:
D200	2001

Prompts			
Type	Condition	Name	Wording
Initial	Always	D201_1	If you want me to repeat the instructions, say 'repeat'. If you are ready to enable calling Santa for your child, say 'done'.
Timeout 1	Always	PM_no_input_1	I'm sorry; I didn't quite understand what you said. Can you repeat that one more time?
Timeout 2	Always	PM_no_input_2	I'm sorry – I still didn't catch that.
Retry 1	Always	PM_no_match_1	I didn't hear your response.
Retry 2	Always	PM_no_match_2	I'm sorry – I didn't hear anything again.
Timeout 3 / Retry 3	Always	PM_final	I'm sorry; I couldn't quite get that. Let me transfer you to one of my elves, they'll be able to help.

Option	Vocabulary	DTMF	Action	Confirm.
Repeat	repeat (it/that); say again	1	Go to D200.	No.
Done	(I'm) done; finish; enable	2	Go to D202.	No.

Other Module Settings / Notes
Three consecutive timeouts or retries will cause the user to be transferred to a representative. The initial prompt is repeated after Timeouts 1 and 2, and after Retry 2.

D202_Enable_calling_Santa

Run logic

Entering from state codes:	Corresponds to Angel state numbers:
D201	2002, 2003

Condition	Action
Always	Update database; go to D203.

Other Module Settings / Notes

D203_End_call_with_password_reminder

Play Prompt

Entering from state code:	Corresponds to Angel state numbers:
D202, D400	2004

Prompts		
Condition	Name	Wording
Always	D203_1	Fantastic! The next time that 'Santa's Residence' is called, I will automatically answer to speak with your child. I look forward to hearing what he or she wants for Christmas! Remember to say 'Rudolph' when I ask 'Who is calling me?' to access your child's wish list! Thank you for calling 'Santa's Residence'! Merry Christmas!

Condition	Action
Always	End the call.

Other Module Settings / Notes

4.3. State Tables – Child Interface (D300 – D311)

D300_Ask_for_caller_name_password
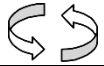
Speech Input

Entering from state codes:	Corresponds to Angel state numbers:
D100	3000

Prompts			
Type	Condition	Name	Wording
Initial	Always	D300_1	Ho ho ho! Merry Christmas! You have reached the North Pole! This is Santa speaking! Whom may I ask is calling my arctic toy factory?

Option	Vocabulary	DTMF	Action	Confirm.
Password match	Rudolph	*	Go to D400.	No.
No match	< none, triggered on the first timeout / retry >		Go to D301.	No.

Other Module Settings / Notes
Barge-in is disabled, to better mimic a real conversation.

D301_Child_opening_interaction

Play Prompt

Entering from state code:	Corresponds to Angel state numbers:
D300	3001

Prompts		
Condition	Name	Wording
Always	D301_1	Why hello! Have you been good this year?
	Silence_2s	< silence for 2 seconds >
	D301_2	Let me check my Naughty and Nice book!
	Silence_1s	< silence for 1 second >
	D301_3	Ah! Here we go! It looks like you are on the nice list this year! Well, do you know what the kids on the nice list get for Christmas?
	Silence_2s	< silence for 2 seconds >
	D301_4	I try to give them a special toy or gift that makes them very happy! It's a very busy time of year right now, but I would love to hear a few of the gifts on your Christmas list!

Condition	Action
Always	Go to D302.

Other Module Settings / Notes
Barge-in is disabled, to better mimic a real conversation.

D302_Recognize_first_wish

Entering from state codes:	Corresponds to Angel state numbers:
D301	3002, 3003, 3010

Prompts			
Type	Condition	Name	Wording
Initial	Always	D302_1	What is the one gift that you want most for Christmas?
Timeout 1	Always	D302_no_input_1	No need to be shy! Go ahead and tell Santa what you want for Christmas!
Timeout 2	Always	D302_no_input_2	I may not be as young as I once was, but I know my hearing's not bad. Please tell me your number one gift this year.
Timeout 3	Always	Wish_final_no_input	I'm sorry, but I have to go – there are other children who are trying to call and tell me their gifts. If you think of anything else, please do call back! I love talking about Christmas presents!

Option	Vocabulary	DTMF	Action	Confirm.
Wish recognized	Xbox; teddy (bear); (Barbie) doll; (video) camera; football; (smart) phone; iPod; scooter; puppy; Lego (bricks)	0-9	Save wish; go to D303.	No.
No match	< triggered on no match events >		Go to D304.	No.

| Other Module Settings / Notes |
|---|
| Barge-in is disabled, to better mimic a real conversation. After the third timeout prompt, the call is ended. |

D303_Respond_to_first_wish

Play Prompt

Entering from state code:	Corresponds to Angel state numbers:
D302	3100 – 3109, 3200 – 3204

Prompts		
Condition	Name	Wording
If wish is Xbox	Wish_xbox	That sounds great! Maybe I can convince the elves to add a game to that Xbox, so that you can test it out right away!
If wish is teddy bear	Wish_teddy	Oh yes! There's nothing quite like hugging your teddy bear while it's snowing outside.
If wish is doll	Wish_doll	A doll... Of course. We'll make a special one just for you!
If wish is camera	Wish_camera	Taking photos is a really fun! I'll make sure the elves find a nice camera for you!
If wish is football	Wish_football	Football is one of my favorite sports! You got it!
If wish is phone	Wish_phone	A phone, you say? I agree! It's a good thing to have and you'll be able to call the elves any time of day!
If wish is iPod	Wish_ipod	I have an iPod, too! All full of my favorite magical Christmas songs!
If wish is scooter	Wish_scooter	I love scooters! If there wasn't so much snow up here in the North Pole, I would scooter everywhere!
If wish is puppy	Wish_puppy	A puppy?! I might have to talk to your parents about that first! They're a lot of work, but so cute!
Else	Wish_legos	The elves love building too! Sometimes I think there are more Legos in our house than there is snow on entire the North Pole!

Condition	Action
Always	Save wish in database; go to D305.

Other Module Settings / Notes
Barge-in is disabled, to better mimic a real conversation.

D304_Record_first_wish
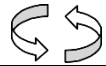
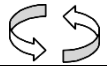| Entering from state codes:	Corresponds to Angel state numbers:
D302	3110, 3111, 3200 – 3204, 3300 – 3309, 3400, 3401, 3500 – 3504

Prompts			
Type	Condition	Name	Wording
Initial 1	Randomly chosen	Excuse_1	Oh no… I think there is a blizzard starting outside. Brrr.. So cold! What was that last gift, little one?
Initial 2	Randomly chosen	Excuse_2	< dropping phone > Clumsy me. Forgive old Papa Frost! What was that last gift on your list?
Initial 3	Randomly chosen	Excuse_3	That must be something new! I must tell my elves to put it on the special list, can you repeat it so that I make sure they get everything right?
Initial 4	Randomly chosen	Excuse_4	< to the side > JUST A MINUTEEE! Miss Claus says dinner is ready – wonder what she made today! I think I missed that last gift though, what was it again?
Initial 5	Randomly chosen	Excuse_5	Did you hear that noise? Reindeers' sneezing is the loudest! They made me miss your last wish – can you say that one again?
Initial 6	Randomly chosen	Excuse_6	< talking in the background > The elves just came home and they're talking so much! Sorry about that, what did you say?
Initial 7	Randomly chosen	Excuse_7	Sorry there, little one! The elves came with a new idea for a gift for Mrs. Claus and I missed what you said. What was it that you wanted?
Initial 8	Randomly chosen	Excuse_8	Oh, no! My clumsy little elves – marshmallows everywhere. Though the hot chocolate smells delicious. I'm sorry, what was it that you wanted?
Initial 9	Randomly chosen	Excuse_9	These phones on the North Pole… The service doesn't always work with all the cold! I didn't catch that last wish of yours - what was it again?
Initial 10	Randomly chosen	Excuse_10	Forgive Papa Frost, but those ears aren't so young anymore. Say that wish one more time?
Response 1	Randomly chosen	Generic_response_1	What a great choice! I will send your request to the toy factory!
Response 2	Randomly chosen	Generic_response_2	Why haven't I thought to put that on my list yet? I like that idea!
Response 3	Randomly chosen	Generic_response_3	Mmmm... I think my elves will have fun with that one!

| Response 4 | Randomly chosen | Generic_response_4 | Ah yes! I'm writing that down now! |
| Response 5 | Randomly chosen | Generic_response_5 | Ho ho ho! You have such great taste! |

Option	Vocabulary	DTMF	Action	Confirm.
Record wish	< none, recording >		Record user's voice; save in database; go to D305.	No.

Other Module Settings / Notes
Barge-in is disabled, to better mimic a real conversation. The recording ends after 1s of silence or maximum 7s of recording, whichever happens sooner. Response prompts are played after the recording is complete.

D305_Recognize_second_wish

Speech Input

Entering from state codes:	Corresponds to Angel state numbers:
D303, D304	3004, 3005, 3010

Prompts			
Type	Condition	Name	Wording
Initial	Always	D305_1	Do you have another gift that you would like for Christmas?
Timeout 1	Always	D305_no_input_1	There are so many choices! And I would really love to hear what would make you happy to unwrap this Christmas!
Timeout 2	Always	D305_no_input_2	It took me a bit to decide what I wanted to on my Christmas list too. If you don't know right now, you can tell me that you're done with your list and give good ol' Santa another call!
Timeout 3	Always	Wish_final_no_input	I'm sorry, but I have to go – there are other children who are trying to call and tell me their gifts. If you think of anything else, please do call back! I love talking about Christmas presents!

Option	Vocabulary	DTMF	Action	Confirm.
Wish recognized	Xbox; teddy (bear); (Barbie) doll; (video) camera; football; (smart) phone; iPod; scooter; puppy; Lego (bricks)	0-9	Save wish; go to D306.	No.
No match	< triggered on no match events >		Go to D307.	No.
Done	(I'm) done; nothing; none; no		Go to D311.	No.

| Other Module Settings / Notes |
|---|
| Barge-in is disabled, to better mimic a real conversation. After the third timeout prompt, the call is ended. |

D306_Respond_to_second_wish

Play Prompt

Entering from state code:	Corresponds to Angel state numbers:
D305	3100 – 3109, 3200 – 3204

Prompts		
Condition	Name	Wording
If wish is Xbox	Wish_xbox	That sounds great! Maybe I can convince the elves to add a game to that Xbox, so that you can test it out right away!
If wish is teddy bear	Wish_teddy	Oh yes! There's nothing quite like hugging your teddy bear while it's snowing outside.
If wish is doll	Wish_doll	A doll... Of course. We'll make a special one just for you!
If wish is camera	Wish_camera	Taking photos is a really fun! I'll make sure the elves find a nice camera for you!
If wish is football	Wish_football	Football is one of my favorite sports! You got it!
If wish is phone	Wish_phone	A phone, you say? I agree! It's a good thing to have and you'll be able to call the elves any time of day!
If wish is iPod	Wish_ipod	I have an iPod, too! All full of my favorite magical Christmas songs!
If wish is scooter	Wish_scooter	I love scooters! If there wasn't so much snow up here in the North Pole, I would scooter everywhere!
If wish is puppy	Wish_puppy	A puppy?! I might have to talk to your parents about that first! They're a lot of work, but so cute!
Else	Wish_legos	The elves love building too! Sometimes I think there are more Legos in our house than there is snow on entire the North Pole!

Condition	Action
Always	Save wish in database; go to D308.

Other Module Settings / Notes
Barge-in is disabled, to better mimic a real conversation.

D307_Record_second_wish
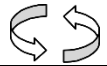
Speech Input

Entering from state codes:	Corresponds to Angel state numbers:
D305	3110, 3111, 3200 – 3204, 3300 – 3309, 3400, 3401, 3500 – 3504

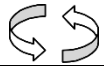| Prompts			
Type	Condition	Name	Wording
Initial 1	Randomly chosen	Excuse_1	Oh no… I think there is a blizzard starting outside. Brrr.. So cold! What was that last gift, little one?
Initial 2	Randomly chosen	Excuse_2	< dropping phone > Clumsy me. Forgive old Papa Frost! What was that last gift on your list?
Initial 3	Randomly chosen	Excuse_3	That must be something new! I must tell my elves to put it on the special list, can you repeat it so that I make sure they get everything right?
Initial 4	Randomly chosen	Excuse_4	< to the side > JUST A MINUTEEE! Miss Claus says dinner is ready – wonder what she made today! I think I missed that last gift though, what was it again?
Initial 5	Randomly chosen	Excuse_5	Did you hear that noise? Reindeers' sneezing is the loudest! They made me miss your last wish – can you say that one again?
Initial 6	Randomly chosen	Excuse_6	< talking in the background > The elves just came home and they're talking so much! Sorry about that, what did you say?
Initial 7	Randomly chosen	Excuse_7	Sorry there, little one! The elves came with a new idea for a gift for Mrs. Claus and I missed what you said. What was it that you wanted?
Initial 8	Randomly chosen	Excuse_8	Oh, no! My clumsy little elves – marshmallows everywhere. Though the hot chocolate smells delicious. I'm sorry, what was it that you wanted?
Initial 9	Randomly chosen	Excuse_9	These phones on the North Pole… The service doesn't always work with all the cold! I didn't catch that last wish of yours - what was it again?
Initial 10	Randomly chosen	Excuse_10	Forgive Papa Frost, but those ears aren't so young anymore. Say that wish one more time?
Response 1	Randomly chosen	Generic_response_1	What a great choice! I will send your request to the toy factory!
Response 2	Randomly chosen	Generic_response_2	Why haven't I thought to put that on my list yet? I like that idea!
Response 3	Randomly chosen	Generic_response_3	Mmmm... I think my elves will have fun with that one!

| Response 4 | Randomly chosen | Generic_response_4 | Ah yes! I'm writing that down now! |
| Response 5 | Randomly chosen | Generic_response_5 | Ho ho ho! You have such great taste! |

Option	Vocabulary	DTMF	Action	Confirm.
Record wish	< none, recording >		Record user's voice; save in database; go to D308.	No.

Other Module Settings / Notes
Barge-in is disabled, to better mimic a real conversation. The recording ends after 1s of silence or maximum 7s of recording, whichever happens sooner. Response prompts are played after the recording is complete.

D308_Recognize_final_wish

Speech Input

Entering from state codes:	Corresponds to Angel state numbers:
D306, D307	3006, 3007, 3010

Prompts			
Type	Condition	Name	Wording
Initial	Always	D308_1	Ooh! I can smell Mrs. Clauss dinner! You know, Santa needs to eat up before his big night! I must go soon for dinner, but is there one last gift that you would like me to put on your list?
Timeout 1	Always	D308_no_input_1	Still thinking? If you've run out of wishes, go ahead and let me know that you're done! Otherwise, I would love to hear that next gift that you want Santa to bring for Christmas!
Timeout 2	Always	D308_no_input_2	No need to worry if you can't think of anything else right now. You can let me know that you're done making your Christmas list and then you can always call back later!
Timeout 3	Always	Wish_final_no_input	I'm sorry, but I have to go – there are other children who are trying to call and tell me their gifts. If you think of anything else, please do call back! I love talking about Christmas presents!

Option	Vocabulary	DTMF	Action	Confirm.
Wish recognized	Xbox; teddy (bear); (Barbie) doll; (video) camera; football; (smart) phone; iPod; scooter; puppy; Lego (bricks)	0-9	Save wish; go to D309.	No.
No match	< triggered on no match events >		Go to D310.	No.
Done	(I'm) done; nothing; none; no		Go to D311.	No.

| Other Module Settings / Notes |
|---|
| Barge-in is disabled, to better mimic a real conversation. After the third timeout prompt, the call is ended. |

D309_Respond_to_final_wish

Play Prompt

Entering from state code:	Corresponds to Angel state numbers:
D308	3100 – 3109, 3200 – 3204

Prompts		
Condition	Name	Wording
If wish is Xbox	Wish_xbox	That sounds great! Maybe I can convince the elves to add a game to that Xbox, so that you can test it out right away!
If wish is teddy bear	Wish_teddy	Oh yes! There's nothing quite like hugging your teddy bear while it's snowing outside.
If wish is doll	Wish_doll	A doll... Of course. We'll make a special one just for you!
If wish is camera	Wish_camera	Taking photos is a really fun! I'll make sure the elves find a nice camera for you!
If wish is football	Wish_football	Football is one of my favorite sports! You got it!
If wish is phone	Wish_phone	A phone, you say? I agree! It's a good thing to have and you'll be able to call the elves any time of day!
If wish is iPod	Wish_ipod	I have an iPod, too! All full of my favorite magical Christmas songs!
If wish is scooter	Wish_scooter	I love scooters! If there wasn't so much snow up here in the North Pole, I would scooter everywhere!
If wish is puppy	Wish_puppy	A puppy?! I might have to talk to your parents about that first! They're a lot of work, but so cute!
Else	Wish_legos	The elves love building too! Sometimes I think there are more Legos in our house than there is snow on entire the North Pole!

Condition	Action
Always	Save wish in database; go to D311.

Other Module Settings / Notes
Barge-in is disabled, to better mimic a real conversation.

D310_Record_final_wish
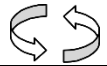
Speech Input

Entering from state codes:	Corresponds to Angel state numbers:
D308	3110, 3111, 3200 – 3204, 3300 – 3309, 3400, 3401, 3500 – 3504

Prompts			
Type	Condition	Name	Wording
Initial 1	Randomly chosen	Excuse_1	Oh no… I think there is a blizzard starting outside. Brrr.. So cold! What was that last gift, little one?
Initial 2	Randomly chosen	Excuse_2	< dropping phone > Clumsy me. Forgive old Papa Frost! What was that last gift on your list?
Initial 3	Randomly chosen	Excuse_3	That must be something new! I must tell my elves to put it on the special list, can you repeat it so that I make sure they get everything right?
Initial 4	Randomly chosen	Excuse_4	< to the side > JUST A MINUTEEE! Miss Claus says dinner is ready – wonder what she made today! I think I missed that last gift though, what was it again?
Initial 5	Randomly chosen	Excuse_5	Did you hear that noise? Reindeers' sneezing is the loudest! They made me miss your last wish – can you say that one again?
Initial 6	Randomly chosen	Excuse_6	< talking in the background > The elves just came home and they're talking so much! Sorry about that, what did you say?
Initial 7	Randomly chosen	Excuse_7	Sorry there, little one! The elves came with a new idea for a gift for Mrs. Claus and I missed what you said. What was it that you wanted?
Initial 8	Randomly chosen	Excuse_8	Oh, no! My clumsy little elves – marshmallows everywhere. Though the hot chocolate smells delicious. I'm sorry, what was it that you wanted?
Initial 9	Randomly chosen	Excuse_9	These phones on the North Pole… The service doesn't always work with all the cold! I didn't catch that last wish of yours - what was it again?
Initial 10	Randomly chosen	Excuse_10	Forgive Papa Frost, but those ears aren't so young anymore. Say that wish one more time?
Response 1	Randomly chosen	Generic_response_1	What a great choice! I will send your request to the toy factory!
Response 2	Randomly chosen	Generic_response_2	Why haven't I thought to put that on my list yet? I like that idea!
Response 3	Randomly chosen	Generic_response_3	Mmmm... I think my elves will have fun with that one!

| Response 4 | Randomly chosen | Generic_response_4 | Ah yes! I'm writing that down now! |
| Response 5 | Randomly chosen | Generic_response_5 | Ho ho ho! You have such great taste! |

Option	Vocabulary	DTMF	Action	Confirm.
Record wish	< none, recording >		Record user's voice; save in database; go to D311.	No.

Other Module Settings / Notes
Barge-in is disabled, to better mimic a real conversation. The recording ends after 1s of silence or maximum 7s of recording, whichever happens sooner. Response prompts are played after the recording is complete.

D311_End_child_call

Play Prompt

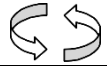| Entering from state code:	Corresponds to Angel state numbers:
D305, D308, D309, D310	3008

Prompts		
Condition	Name	Wording
Always	D309_1	Well my dear child, thank you so much for calling me up here at the North Pole and sharing your Christmas gift list with me! Ill send your wishes directly to the elves in the toy factory! In the meantime, make sure that you are really good, because I'll be checking my list ... and checking it twice! The reindeer are excited to visit your rooftop soon - maybe you could leave some carrots out for them on Christmas Eve! Goodbye!
	Silence_2s	< silence for 2 seconds >
	D309_2	Merry Christmas!

Condition	Action
Always	End the call.

Other Module Settings / Notes
Barge-in is disabled, to better mimic a real conversation.

4.4. State Tables – Parent Interface (D400 – D410)

D400_Parent_menu

Speech Input

Entering from state codes:	Corresponds to Angel state numbers:
D300	4000 – 4002, 4015

Prompts			
Type	Condition	Name	Wording
Initial 1	If wish list is empty	D400_empty	Santa's residence. This is Santa! Unfortunately, I do not have any wishes on record for your child yet. Please allow your child to call this number back, and I will let you know what they would like under the Christmas tree. If you need help using the system, please say 'help'. If you are ready to have your child call me, please say 'done'.
Initial 2	If wish list is not empty	D400_not_empty	Santa's Residence. This is Santa! Would you like to access your child's Christmas wish list for Santa or would you like me to help you use the system? Please say either 'wish list' or 'help'.
Timeout 1	Always	PM_no_input_1	I'm sorry; I didn't quite understand what you said. Can you repeat that one more time?
Timeout 2	Always	PM_no_input_2	I'm sorry – I still didn't catch that.
Retry 1	Always	PM_no_match_1	I didn't hear your response.
Retry 2	Always	PM_no_match_2	I'm sorry – I didn't hear anything again.
Timeout 3 / Retry 3	Always	PM_final	I'm sorry; I couldn't quite get that. Let me transfer you to one of my elves, they'll be able to help.

Option	Vocabulary	DTMF	Action	Confirm.
Wish list (only available if there are saved wishes	(wish) list	1	Go to D402.	No.
Help	help (me); what should I say	2	Go to D401.	No.
Done	(I am) done; finish	3	Go to D203.	No.

Other Module Settings / Notes
Three consecutive timeouts or retries will cause the user to be transferred to a representative. The initial prompt is repeated after Timeouts 1 and 2, and after Retry 2.

D401_Parent_help

Play Prompt

Entering from state code:	Corresponds to Angel state numbers:
D400	4017

Prompts		
Condition	Name	Wording
Always	System_help	'Santa's Residence' is a phone system designed with your child in mind. Once you enable the system, your child will be able to call me, Santa, at the North Pole! I will ask about the gifts on his or her Christmas list this year and save them in our toy factory database. After your child has told me what he or she wants, you can access this wish list by calling back. When I ask 'Who is calling me?' at the beginning of future calls, if you say the password 'Rudolph', you will be taken to a menu in which you can hear what your child has asked for.

Condition	Action
Always	Go to D400.

Other Module Settings / Notes

D402_Explain_wish_list_structure

Play Prompt

Entering from state code:	Corresponds to Angel state numbers:
D400	4003, 4004

Prompts		
Condition	Name	Wording
Always	D402_1	Okay, I will read your child's wish list back to you one item at a time. After each item, you can say 'repeat it' to hear it again, or 'continue' to move on to the next item. Oh, and if I was unable to understand what your child asked for, I will play back a recording of what he or she said.

Condition	Action
Always	Set wish index to 0; go to D403.

Other Module Settings / Notes

D403_Get_next_wish_from_db

Run logic

Entering from state codes:	Corresponds to Angel state numbers:
D402	4005, 4010

Condition	Action
Always	Increment wish index; load wish from database; go to D404.

Other Module Settings / Notes

D404_Check_wish_type

Branch on Condition

Entering from state codes:	Corresponds to Angel state numbers:
D403	4011

Condition	Action
IF wish is recognized	Go to D405.
Else	Go to D406.

Other Module Settings / Notes

D405_Read_recognized_wish
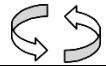
Speech Input

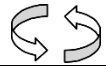| Entering from state codes:	Corresponds to Angel state numbers:
D404	4012

Prompts			
Type	Condition	Name	Wording
Initial	Always	D405_1	The next wish is a
		Variable	< wish >
		D405_2	Do you want me to repeat it or continue?
Timeout 1	Always	PM_no_input_1	I'm sorry; I didn't quite understand what you said. Can you repeat that one more time?
Timeout 2	Always	PM_no_input_2	I'm sorry – I still didn't catch that.
Retry 1	Always	PM_no_match_1	I didn't hear your response.
Retry 2	Always	PM_no_match_2	I'm sorry – I didn't hear anything again.
Timeout 3 / Retry 3	Always	PM_final	I'm sorry; I couldn't quite get that. Let me transfer you to one of my elves, they'll be able to help.

Option	Vocabulary	DTMF	Action	Confirm.
Repeat	(say) again; repeat (it)	1	Go to D404.	No.
Continue	continue; go ahead; next	2	Go to D407.	No.

Other Module Settings / Notes
Three consecutive timeouts or retries will cause the user to be transferred to a representative. The initial prompt is repeated after Timeouts 1 and 2, and after Retry 2.

D406_Play_recorded_wish

Speech Input

Entering from state codes:	Corresponds to Angel state numbers:
D404	4013

Prompts			
Type	Condition	Name	Wording
Initial	Always	D406_1	I was unable to understand this wish. This is what your child said:
		Variable	< wish recording >
		D406_2	Do you want me to repeat it or continue?
Timeout 1	Always	PM_no_input_1	I'm sorry; I didn't quite understand what you said. Can you repeat that one more time?
Timeout 2	Always	PM_no_input_2	I'm sorry – I still didn't catch that.
Retry 1	Always	PM_no_match_1	I didn't hear your response.
Retry 2	Always	PM_no_match_2	I'm sorry – I didn't hear anything again.
Timeout 3 / Retry 3	Always	PM_final	I'm sorry; I couldn't quite get that. Let me transfer you to one of my elves, they'll be able to help.

Option	Vocabulary	DTMF	Action	Confirm.
Repeat	(say) again; repeat (it)	1	Go to D404.	No.
Continue	continue; go ahead; next	2	Go to D407.	No.

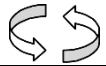| Other Module Settings / Notes |
|---|
| Three consecutive timeouts or retries will cause the user to be transferred to a representative. The initial prompt is repeated after Timeouts 1 and 2, and after Retry 2. |

D407_Check_if_all_wishes_read

Branch on Condition

Entering from state codes:	Corresponds to Angel state numbers:
D405, D406	4005, 4014

Condition	Action
IF more wishes to be read	Increment wish index; go to D403.
Else	Go to D408.

Other Module Settings / Notes

D408_Finish_reading_wish_list

Speech Input

Entering from state codes:	Corresponds to Angel state numbers:
D407	4006

Prompts			
Type	Condition	Name	Wording
Initial	Always	D408_1	That was the last item on your child's wish list. If you would like to hear the list again, say 'repeat it'. If you would like to delete the list, say 'delete it'. Otherwise, please say 'I'm done'.
Timeout 1	Always	PM_no_input_1	I'm sorry; I didn't quite understand what you said. Can you repeat that one more time?
Timeout 2	Always	PM_no_input_2	I'm sorry – I still didn't catch that.
Retry 1	Always	PM_no_match_1	I didn't hear your response.
Retry 2	Always	PM_no_match_2	I'm sorry – I didn't hear anything again.
Timeout 3 / Retry 3	Always	PM_final	I'm sorry; I couldn't quite get that. Let me transfer you to one of my elves, they'll be able to help.

Option	Vocabulary	DTMF	Action	Confirm.
Repeat	repeat (it); start over	1	Set wish index to 0; go to D403.	No.
Done	(I am) done	2	Go to D410.	No.
Clear wish list	clear (it); erase (it); delete (it)	*	Go to D409.	No.

Other Module Settings / Notes
Three consecutive timeouts or retries will cause the user to be transferred to a representative. The initial prompt is repeated after Timeouts 1 and 2, and after Retry 2.

D409_Clear_wish_list

Entering from state codes:	Corresponds to Angel state numbers:
D408	4008, 4009

Condition	Action
Always	Erase wishes from database; go to D410.

Other Module Settings / Notes

D410_End_parent_call

Play Prompt

Entering from state code:	Corresponds to Angel state numbers:
D408, D409	4007

Prompts		
Condition	Name	Wording
Always	D410_1	All right. Thank you for calling Santa's Residence! Merry Christmas!

Condition	Action
Always	End the call.

Other Module Settings / Notes

5.   Usability Testing

The designers of a system often have a certain perception as to what their system does and how they expect it to do so. What made sense according to the authors may sound like complete gibberish to someone who is listening to the system for the first time. Usability testing was necessary to ensure that our design was not susceptible to this issue, and that all aspects of the system are performing to specification.

The usability testing included pre-test and post-test questionnaires, two different test scripts that testers alternated between, and a post-test debriefing. We conducted a single external round of usability testing with eight people, as we felt that testing the system without an appropriate Santa voice would be futile. Four of these people would experience the system from just the child's perspective, hearing only the prompts that are intended to generate a list of gifts. The other four people would see all aspects of the system, being representative of a parent that receives the instructions, hears what their child would listen to and interacts with it, and then re-accesses the gifts that they just entered. This division in the tasks performed by different subjects was to gather a sense of how the two primary stakeholders would interact and respond to the system.

Usability Test #1

Usability Test 1 was completed by a student, covering all three menus of the system. The feedback was overall very positive and the user agreed that the voice had the correct character of a Santa. However, although she said the prompt "puppy", it was not recognized at first and thus needed to be recorded. Also, sometimes an automated timeout prompt came on, but that may have been the fault of the new set of prompts not being uploaded at the time. The user also asked what happens when a kid's name is actually Rudolph, but we felt that this risk was reasonably small to not change our design.

Usability Test #2

Usability test 2 was completed by an actual parent who also is a special education teacher, and thus has constant interaction with small children. In addition to just obtaining feedback from the pre-test questionnaire and post-test questionnaire, we sought oral feedback for the appropriateness of a system for a young child. She responded that the level of speech in some of the prompts could potentially be a little high for some young children or children with learning impairment, but that the idea of the system and the approach that we took would be perfect for getting children excited about the holiday season. As a parent, she also liked the feature of allowing parental access to the gift list.

Usability Test #3

Usability test 3 tested only the child portion of the system. This subject had the difficulty of Santa responding to her "Umm" and then when she said "Teddy Bear" the system took it as a barge-in for the response that had just started and directed the call to the final state. This issue was investigated on Angel, but no errors were found. Barge-in capabilities were turned off on all applicable states, but it was determined that it was most likely an error on Angel's part because the sequence of events did not correspond to any sequence of states specified in Angel.

Usability Test #4

Usability test 4 followed the test script that tested all three menus of the system. The user's wishes were not part of the system's vocabulary and thus needed to be recorded, and the user felt that the system handled the situation very smoothly and light-heartedly. When the system asked for the third (and final) wish, the user intentionally did not respond because he was "curious to see if the system would react reasonably." Santa's Residence then played through the three 'no input' prompts before ending the call (as designed), and the user was left very satisfied by the design.

Usability Test #5

Usability test 5 followed the script that only tested the child portion of the system. The user intentionally asked for uncommon gifts (including a unicorn) and was very amused by the randomized excuse prompts. Unfortunately, as she was laughing while repeating her wish for the recording, the system did not detect the end of her speech and continued recording until the maximum recording time of ten seconds was reached, prompting the user to feel that the system wasn't recognizing her wish for a second time. As a result of this, we decided to shorten the maximum recording time and the minimum silence time necessary to stop recording.

Usability Test #6

Usability test 6 tested only the child portion of the phone system. The first two wishes were chosen from the list of recognized prompts, the "puppy" and "Xbox". For the third wish, he said "no finals", which resulted in transferring to the voice-recording page. When the prompt came again, he said "weights". There were no major issues or problems with the voice system during the testing. However, he would have liked the system to save the answer the first time around rather than prompting one more time (although this is a limitation of Angel). He also said some of the timeout prompts were a bit long. The overall impression was very positive, as he stated he would be very likely to use this system with a child.
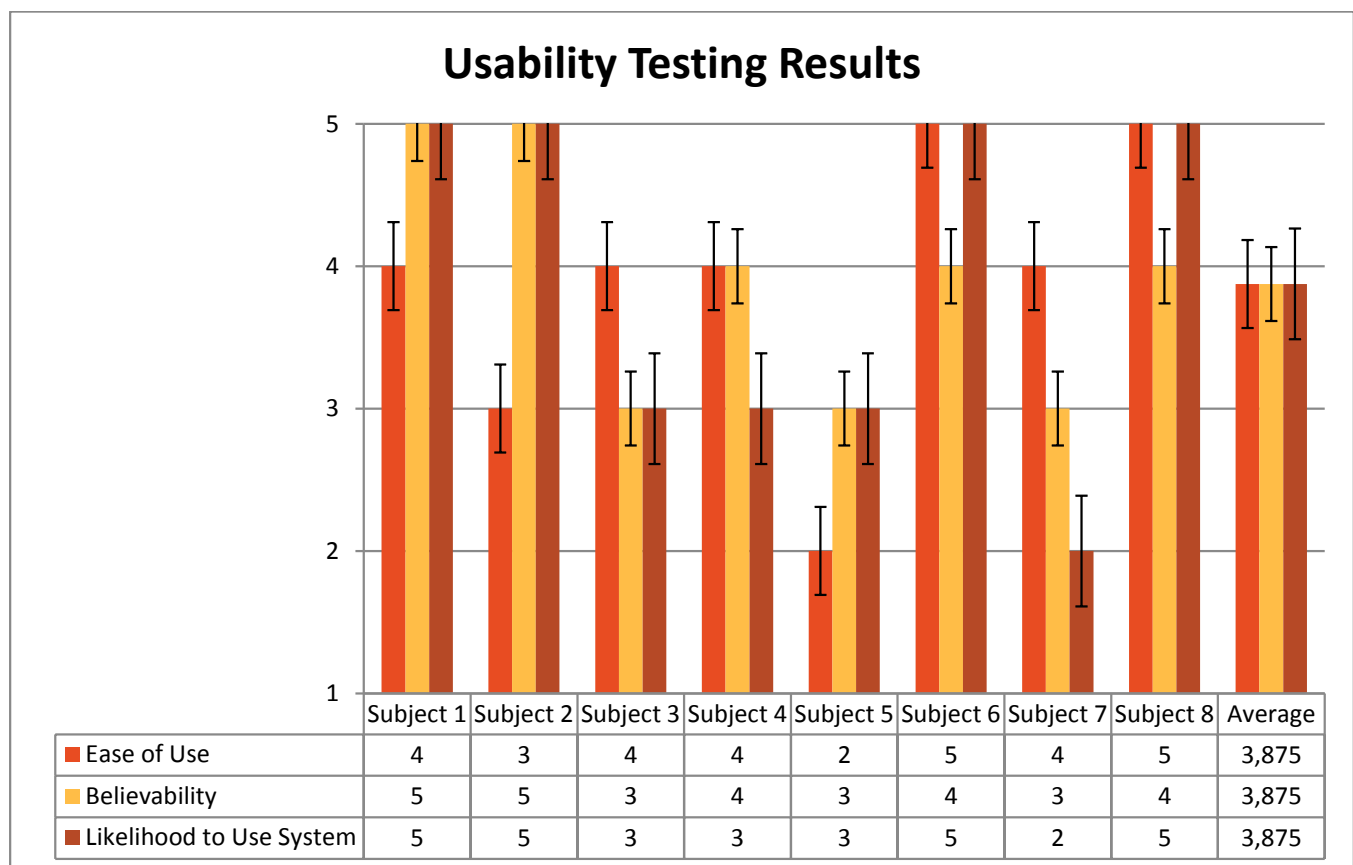
Usability Test #7

Usability test 7 was similar to the other testers who tested all three portions of the test. They expressed that the system was easy to use and could be very useful. However, the major concern was believability as they felt that the audio quality was not sufficiently high.

Usability Test #8

Usability test 8 tested the child portion of the phone system. The user rated the system very positively and agreed that this was a unique system that would likely work for young children. They found the system easy to use and appreciated the custom prompts for each wish.

Usability Testing Summary

Here is a summary of the results gathered in the post-test questionnaires:

Usability Testing Results

	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	Subject 7	Subject 8	Average
Ease of Use	4	3	4	4	2	5	4	5	3,875
Believability	5	5	3	4	3	4	3	4	3,875
Likelihood to Use System	5	5	3	3	3	5	2	5	3,875

The usability tests uncovered some glitches in the system that were addressed in Angel, hence the two users with drastically lowered 'ease of use' and 'likelihood to use' ratings. Other than that, we feel that our system performed admirably and was received very well by users.

As has been previously stated, the believability of Santa Claus is crucial. We were very pleased that all but two of our subjects thought that the Santa voice was between somewhat and very believable. There were several comments about how the quality of the voice should be improved, but unfortunately we were limited by Angel on that aspect of the system. We also learned that the subjects would like to hear a few more of Santa's signature "ho ho ho"s.

One user suggested considering playability by making more randomized prompts for all parts of the system. While we understand that this would be ideal, given the limited time we had available, we felt that we had to prioritize the no-match excuse and response prompts above this.

Two users also commented on the beep that sounds before recording the wish when the system is asking for it for a second time. Unfortunately, this is also something that Angel implements that we cannot get around. We decided the best way to deal with this issue is to ignore it – as Angel's sound quality is not stellar and the voiced prompts completely ignore the beep, we felt that users would choose to ignore it as well.

Overall, our usability testers were pleased with the system and felt the Christmas vibe throughout. As a result, most reported that they would encourage a child to use this system.

6. Conclusion

The magic of Christmas is what makes the holiday so special for children. The concept of a man wearing all red who travels around the world in a single night encourages the imagination of young kids to run wild. The excitement and anticipation of the waking up to a stack of beautifully wrapped gifts under a Christmas tree means that Santa needs to know exactly what should be inside those packages! "Santa's Residence" builds on the magic of Christmas, while also staying up to date with new technology. Letter writing takes too long, and who knows how much Santa remembers after a long day at the mall! Kids will love being able to call and personally talk to Santa himself, and parents can make sure that the believability of Santa is retained by ensuring that all of those gifts that Santa promised end up under the tree on December 25th!

7. Appendices

7.1. Appendix A – Voice Recording Script

Prompt code	Prompt Text
D200_1	Santa's Residence', Santa speaking.
System_help	Santa's Residence' is a phone system designed with your child in mind. Once you enable the system, your child will be able to call me, Santa, at the North Pole! I will ask about the gifts on his or her Christmas list this year and save them in our toy factory database. After your child has told me what he or she wants, you can access this wish list by calling back. When I ask 'Who is calling me?' at the beginning of future calls, if you say the password 'Rudolph', you will be taken to a menu in which you can hear what your child has asked for.
D201_1	If you want me to repeat the instructions, say 'repeat'. If you are ready to enable calling Santa for your child, say 'done'.
D203_1	Fantastic! The next time that 'Santa's Residence' is called, I will automatically answer to speak with your child. I look forward to hearing what he or she wants for Christmas! Remember to say 'Rudolph' when I ask 'Who is calling me?' to access your child's wish list! Thank you for calling 'Santa's Residence'! Merry Christmas!
D300_1	Ho ho ho! Merry Christmas! You have reached the North Pole! This is Santa speaking! Whom may I ask is calling my arctic toy factory?
D301_1	Why hello! Have you been good this year?
D301_2	Let me check my Naughty and Nice book!
D301_3	Ah! Here we go! It looks like you are on the nice list this year! Well, do you know what the kids on the nice list get for Christmas?
D301_4	I try to give them a special toy or gift that makes them very happy! It's a very busy time of year right now, but I would love to hear a few of the gifts on your Christmas list!
D302_1	What is the one gift that you want most for Christmas?

Wish_xbox	That sounds great! Maybe I can convince the elves to add a game to that Xbox, so that you can test it out right away!
Wish_teddy	Oh yes! There's nothing quite like hugging your teddy bear while it's snowing outside.
Wish_doll	A doll… Of course. We'll make a special one just for you!
Wish_camera	Taking photos is a really fun! I'll make sure the elves find a nice camera for you!
Wish_football	Football is one of my favorite sports! You got it!
Wish_phone	A phone, you say? I agree! It's a good thing to have and you'll be able to call the elves any time of day!
Wish_ipod	I have an iPod, too! All full of my favorite magical Christmas songs!
Wish_scooter	I love scooters! If there wasn't so much snow up here in the North Pole, I would scooter everywhere!
Wish_puppy	A puppy?! I might have to talk to your parents about that first! They're a lot of work, but so cute!
Wish_legos	The elves love building too! Sometimes I think there are more Legos in our house than there is snow on entire the North Pole!
Generic_response_1	What a great choice! I will send your request to the toy factory!
D305_1	Do you have another gift that you would like for Christmas?
D308_1	Ooh! I can smell Mrs. Clauss dinner! You know, Santa needs to eat up before his big night! I must go soon for dinner, but is there one last gift that you would like me to put on your list?
D309_1	Well my dear child, thank you so much for calling me up here at the North Pole and sharing your Christmas gift list with me! Ill send your wishes directly to the elves in the toy factory! In the meantime, make sure that you are really good, because I'll be checking my list … and checking it twice! The reindeer are excited to visit your rooftop soon - maybe you could leave some carrots out for them on Christmas Eve! Goodbye!
D309_2	Merry Christmas!
D400_empty	Santa's residence. This is Santa! Unfortunately, I do not have any wishes on record for your child yet. Please allow your child to call this number back, and I will let you know what they would like under the Christmas tree. If

	you need help using the system, please say 'help'. If you are ready to have your child call me, please say 'done'.
D400_not_empty	Santa's Residence. This is Santa! Would you like to access your child's Christmas wishlist for Santa or would you like me to help you use the system? Please say either 'wishlist' or 'help'.
D402_1	Okay, I will read your child's wishlist back to you one item at a time. After each item, you can say 'repeat it' to hear it again, or 'continue' to move on to the next item. Oh, and if I was unable to understand what your child asked for, I will play back a recording of what he or she said.
D410_1	All right. Thank you for calling Santa's Residence! Merry Christmas!
D408_1	That was the last item on your child's wish list. If you would like to hear the list again, say 'repeat it'. If you would like to delete the list, say 'delete it'. Otherwise, please say 'I'm done'.
D405_2	Do you want me to repeat it or continue?
D406_1	I was unable to understand this wish. This is what your child said:
D406_2	Do you want me to repeat it or continue?
D405_1	The next wish is a
teddy bear	teddy bear
Xbox	Xbox
doll	doll
camera	camera
football	football
phone	phone
iPod	iPod
scooter	scooter
puppy	puppy
legos	legos
Excuse_1	Oh no... I think there is a blizzard starting outside. Brrr.. So cold! What was that last gift, little one?
Excuse_2	< dropping phone > Clumsy me. Forgive old Papa Frost! What was that last gift on your list?

Excuse_3	That must be something new! I must tell my elves to put it on the special list, can you repeat it so that I make sure they get everything right?
Excuse_4	< to the side > JUST A MINUTEEE! Miss Claus says dinner is ready - wonder what she made today! I think I missed that last gift though, what was it again?
Excuse_5	Did you hear that noise? Reindeers' sneezing is the loudest! They made me miss your last wish - can you say that one again?
Excuse_6	< talking in the background > The elves just came home and they're talking so much! Sorry about that, what did you say?
Excuse_7	Sorry there, little one! The elves came with a new idea for a gift for Mrs. Claus and I missed what you said. What was it that you wanted?
Excuse_8	Oh, no! My clumsy little elves - marshmallows everywhere. Though the hot chocolate smells delicious. I'm sorry, what was it that you wanted?
Excuse_9	These phones on the North Pole… The service doesn't always work with all the cold! I didn't catch that last wish of yours - what was it again?
Excuse_10	Forgive Papa Frost, but those ears aren't so young anymore. Say that wish one more time?
Generic_response_2	Why haven't I thought to put that on my list yet? I like that idea!
Generic_response_3	Mmmm… I think my elves will have fun with that one!
Generic_response_4	Ah yes! I'm writing that down now!
Generic_response_5	Ho ho ho! You have such great taste!
D302_no_input_1	No need to be shy! Go ahead and tell Santa what you want for Christmas!
D302_no_input_2	I may not be as young as I once was, but I know my hearing's not bad. Please tell me your number one gift this year.
D305_no_input_1	There are so many choices! And I would really love to hear what would make you happy to unwrap this Christmas!
D305_no_input_2	It took me a bit to decide what I wanted to on my Christmas list too. If you don't know right now, you can tell me that you're done with your list and give good ol' Santa another call!
D308_no_input_1	Still thinking? If you've run out of wishes, go ahead and let me know that you're done! Otherwise, I would love to hear that next gift that you want Santa to bring for Christmas!

D308_no_input_2	No need to worry if you can't think of anything else right now. You can let me know that you're done making your Christmas list and then you can always call back later!
Wish_final_no_input	I'm sorry, but I have to go -- there are other children who are trying to call and tell me their gifts. If you think of anything else, please do call back! I love talking about Christmas presents!
PM_no_match_1	I'm sorry; I didn't quite understand what you said. Can you repeat that one more time?
PM_no_match_2	I'm sorry -- I still didn't catch that.
PM_no_input_1	I didn't hear your response.
PM_no_input_2	I'm sorry -- I didn't hear anything again.
PM_final	I'm sorry; I couldn't quite get that. Let me transfer you to one of my elves, they'll be able to help.

7.2.   Appendix B – Pre-test and Post-test Questionnaires

Post-Test Questionnaire

Thank you for completing our usability test! Please answer these questions to provide us with notes of your experience of calling "Santa's Residence"

* Required

Name *

This is a required question

How easy to use was the system? *

○ Very Easy

○ Easy

○ Neither Easy nor Difficult

○ Difficult

○ Very Difficult

How believable did "Santa" sound on the phone in the child section? *

○ Very Believable

○ Believable

○ Somewhat Believable

○ Neither Believable nor Not Believable

○ Somewhat Not Believable

○ Not Believable

What could make "Santa" sound more believable? *

If you were a parent, how likely would you be to use a version of this system with your child? *

○ Very Likely

○ Likely

○ Indifferent

○ Not Likely

○ Very Not Likely

Please name three things that could improve the system. *

Submit

7.3. Appendix C – Usability Testing Scripts

"Santa's Residence"

"Santa's Residence" is an interactive phone system designed to allow children to call Santa Claus and tell him his or her Christmas gift list.

In this usability test, you will be calling "Santa's Residence" three times to experience the three different parts of the phone system.

-In the first call, you will hear "Santa"'s explanation of the system to a parent.
-In the second call, you will bring back your inner youth and experience how a child would tell "Santa" his or her wishlist.
-Finally, in the third call, you should access the parent menu and listen back to the gifts for which you asked.

1) Fill out the Pre-Test questionnaire online.

2) Call the number 855-916-7088 to experience the first interface that a parent would interact with.

3) Listen to the instructions given and then enable the system for the child to call Santa.

4) After completing call 1, call 855-916-7088 again for a taste of the child experience.

5) Santa will ask you for three gifts that you want for Christmas. Here are some suggestions:

    An Xbox, a baseball bat, ice skates, a smartphone, a doll, a book, a puppy.

6) Once call 2 has completed, please call 855-916-7088 for the final time and access the parent menu to review the gifts that you have just told Santa that you wanted.

7) Upon completion of call 3, please fill out the Post-Test questionnaire online.

8) Thank You! And Merry Christmas!

"Santa's Residence"

"Santa's Residence" is an interactive phone system designed to allow children to call Santa Claus and tell him his or her Christmas gift list.

In this usability test, you will be calling "Santa's Residence" once to experience how a child would interact with the Santa phone system.

1) Fill out the Pre-Test questionnaire online.

2) Call the number 855-916-7088 to experience the child interface.

3) Santa will ask you for three gifts that you want for Christmas. Here are some suggestions, but feel free to come up with some of your own:

   An Xbox, a baseball bat, ice skates, a smartphone, a doll, a book, a puppy.

4) Upon completion of the call, please fill out the Post-Test questionnaire online.

5) Thank You! And Merry Christmas!

7.4. Appendix D – Anonymized Pre-test Responses

Age	Gender	Have you ever spoken to a "Santa" before?	Have you ever called a system in which you spoke to "Santa"?	Have you ever wanted to talk to a "Santa"?
20	Female	No	No	Yes
47	Female	Yes	No	Yes
21	Female	Yes	No	Yes
19	Male	Yes	No	Yes
18	Female	Yes	No	Yes
20	Male	Yes	No	Yes
19	Male	Yes	No	Yes
20	Female	Yes	No	Yes

7.5. Appendix E – Anonymized Post-test Responses

How easy to use was the system?	How believable did "Santa" sound on the phone in the child section?	What could make "Santa" sound more believable?	If you were a parent, how likely would you be to use a version of this system with your child?	Please name three things that could improve the system.
Easy	Very Believable	more ho ho hos	Very Likely	1. automated voices 2. clearer pronunciation of the options 3. :)
Neither Easy nor Difficult	Very Believable	There needs to be the same voice for the recorded wishes as Santa's voice	Very Likely	Sound needs to be a little clearer. Voices need to be consistent, heard a different voice before recordings.
Easy	Somewhat Believable	Maybe add a few "ho ho hos"	Indifferent	I accidentally said uhhh and it took it as a response. It also cut out in the middle of one of my responses and went to the end. It didn't seem like it was supposed to do that.
Easy	Believable	A deeper, more booming voice is how he is usually portrayed in	Indifferent	The voice recognition was unable to pick up what I wanted for Christmas either time.

		movies. He also sounded a little young to be Santa.		I think it might be better to not ask to repeat the wish (though I appreciated the excused for being unable to hear) If background ambi could be worked in to the recording, that'd be super cool, but only as long as the noise distortion didn't mess with the ability to understand what Santa was saying.
Difficult	Somewhat Believable	The sound interference made Santa less believable and more difficult to hear. Also, some of the responses did not correspond directly to what I asked or mentioned in the conversation.	Indifferent	Sound Quality (primary) More varied conversation Replayability (different responses each time)
Very Easy	Believable	Say "ho ho ho" and "Merry Christmas" more often!	Very Likely	1. Less storytelling about Mrs. Clause. 2. Tell you to leave cookies and milk for Santa. 3. Save gift after first time

				the system doesn't recognize it instead of having to ask again (possibly limited by implementation?).
Easy	Somewhat Believable	if he was a real person	Not Likely	- more than just one gift that i can list (i said yes to the second question and it never asked me for another gift, does that mean i get the first one for sure? also why did it ask if I can't list more) - there is background noise in the recordings, you could remove it to make it better - and the beep sound was weird
Very Easy	Believable	less structured conversation. maybe a random story from Santa somewhere in the middle?	Very Likely	I loved it! - a deeper Santa voice with better quality - no beeping sound if that were possible - maybe an opportunity to list more than just one gift?