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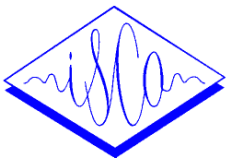

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CHARACTERIZATION OF DIRECTORY ASSISTANCE OPERATOR-CUSTOMER DIALOGUES IN AGT LIMITED

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ABSTRACT

This work focuses on AGT Limited[1] Directory Assistance (DA) Operator Services in Edmonton and is based on recordings of operator-customer dialogues. Twenty five hundred conversations were sampled and transcribed into text. A Directory Assistance State Model (DA-SM) was developed from analyzing the customer-operator dialogues. The model represents the logical stages that exist, and the tasks that are performed by the DA operator while handling a call. Using the model, the major call patterns and subpatterns were identified and their characteristics measured. DA-SM suggested that the operator-customer dialogues follows a logical flow in an organized pattern. The primary operator tasks were then identified for the purpose of finding potential speech recognition applications. From the primary tasks it was identified that the best task for streamlining call flow is early prompting of the location information from the customer.

A field study conducted during eight weeks suggested that the operator could prompt the customer to provide the location information during initial dialogue.

KEY WORDS : Automatic Speech Recognition; Operator Services; Directory Assistance State Model; Human Factors; Speech dialogues;

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I INTRODUCTION

The function of Directory Assistance Operator Services is to provide any caller with listing information about the subscribers within its jurisdiction. The average duration of a call is slightly less than 30 seconds. There were on average 84,657 Directory Assistance calls taken daily within AGT Ltd. The average cost for each call in 1991 was $0.35 which equates to $30,000 per day and approximately $10.8 million annually. If a call duration reduction of only one second is achieved, the cost savings could be approximately $350,000 annually. So, one motivating factor driving the study is the potential reduction in operating costs.

This study characterizes Directory Assistance operator processes and process attributes, for the purpose of identifying operator procedure improvements and voice technology applications in these processes. This work focuses specifically on studying Directory Assistance (DA) Operator Services in Edmonton and is based on recordings of operator-customer dialogues. Twenty five hundred conversations were sampled and transcribed into text. A Directory Assistance State Model (DA-SM) was developed from analyzing the customer-operator dialogues. Major tasks for DA operators were identified. This study also analyzed the use of initial operator dialogues. The second motivation for this study was to improve the customer service by improving operator procedures.

II METHODS

2.1 Operator Interviews

At the start of this study, a questionnaire was formulated and volunteer DA operators were interviewed. From the operator interviews, a process entity diagram was defined, and it was concluded that an analysis of conversation dialogues was required to quantify the operator tasks and their frequency of occurrence.

2.2 Recording the Acoustics of DA Conversations

The next step was to record the acoustics of customer-operator dialogues onto magnetic tape using volunteer operators. To ensure recording integrity, a "signal to noise ratio" test was performed using a HP4934A Transmission Impairment Measurement Set instrument. The test concluded that the signal captured on Digital Audio Tape (DAT) represents the acoustic signal that was fed into the operator's ear-piece (P=1.0).

When an operator received a call during the data collection phase, the customer's permission was obtained before the conversation was recorded. The operator was given control of a remote control switch (DAT controller) to start and stop the recordings.

A total of 2500 conversations were recorded at Edmonton DA. Through sample size calculations, it was concluded that the sample size was adequate for the purpose of this study (Statistical power of 80% and alpha error of 5%). Two recording sessions were conducted. The first recording session was distributed over an entire week (Jan 23-29,1991) and the second recording was done on June 14, 1991. This sample represents 48.5 hours of operator on-line operation, and resulted in 13 DAT tapes containing 24 hours of recorded dialogues. As a result of operator interviews, it was identified that there were four distinct times of the week which were characteristic of different types of customers. The four periods and the number of conversations that were recorded were: 1400 weekday business calls (56%), 500 weekday evening calls (20%), 125 weekday night (12AM to 8AM) calls (5%), and 475 weekend calls (19%).

2.3 Transcription Using Speech Recognition System

Each of the recorded conversations was then transcribed from an acoustic speech signal into text with a header. The details of headers were : (i) unique conversation identification number, (ii) tape counter start/stop values, (iii) date and time of recording, (iv) operator name, (v) whether the recording was authorized (vii) (a) customer gender, subjective measures such as (b) customer age (i.e., child, adolescent, adult, (c) customer accent, (d) customer pronunciation, (vii) background noise type and level (viii) (a) number of listings requested, (b) type of listing(s) requested, and (c) number of listings found, (ix) whether the customer was billed, and (x) if the request was for out of province DA. This was done by using *DragonDictate*™, a speaker dependent 5000 word Automatic Speech Recognition (ASR) PC (MS DOS; 386) system, as an automatic Dictaphone (1). For each of the 2500 recorded conversations, all utterances given by the customer, operator or call announcements were re-spoken into *DragonDictate*, which converted each into text, see Figure 1. The text was entered into Oracle (V5.122.9) database for pattern analysis.

[1] AGT Limited is a Telecommunications subsidiary of Telus Corporation.

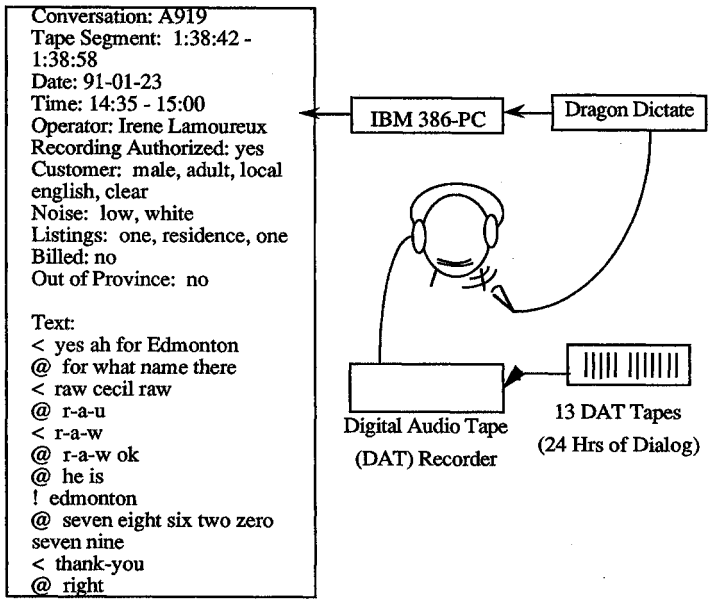

Figure 1. Diagram of Transcription Method

2.4 Directory Assistance State Modelling Techniques

A Directory Assistance State Model (DA-SM)) was developed from the Customer operator dialogue. The DA operator is represented as a system (2). The system lies in rest at a given state, waiting for a trigger of external information. Once triggered, the system performs certain actions and transfers into another state. This is a system event. To arrive at a given state, a sequence of events has to occur. For each conversation, a trigger or triggers, an associated action or actions, a starting state and an ending state were mapped. After mapping 750 conversations, a Directory Assistance State Model was developed. The model represents the logical stages that exist, and the tasks that are performed by the DA operator while handling a call. From the model, the major call patterns and subpatterns were identified and their characteristics measured.

2.5 Directory Assistance Field Trials

A one week field trial was conducted to validate the DA-SM preliminary results. The DA-SM suggested that when the location information (i.e., a city name or a locality name) is accepted in one utterance, followed by name in the second utterance, the call duration will be shorter with less customer-operator interaction, than if the name and location information are accepted in one utterance. An experiment was designed to verify this hypothesis with the operators prompting the customer for the location information at the start of the call, with the objective of measuring the performance the two dialogues by using call durations.

A preliminary field trial with six operators during two one week periods (1991 December 15-21 and 1992 Jan 5-11) suggested that modifying the dialogues of the operators could reduce the call duration by one second. Therefore an eight week (1992 Mar 22 to 1992 May 16) second field trial was conducted with Edmonton DA operators (N>60) using the two types of dialogues. The first ("New") dialogue ("AGT; operator name; What place please") asked the customers to provide location information first after the initial greeting. The second ("Old") dialogue ("AGT Directory; operator name") was similar to current procedures used by the operators. The operators greeted the customers and then allowed the customer's to respond. The study was conducted during business hours (8AM to 5.30 PM).

All data was analyzed using a Statistical Software tool (SAS Institute Inc., Box 8000, Cary, NC 27512-8000, USA).

III RESULTS AND DISCUSSION

3.1 Directory Assistance State Model (DA-SM)

The Directory Assistance State Model was used to identify the primary operator tasks (Table 2), as well as call patterns and their characteristics (Figure 3a and 3b). The model is made up of ten (waiting) states, interconnected by state transitions. The vehicle by which the system transits from one state to another is a system event. Each event signifies stimulus information fed into the system (i.e., the trigger), and the corresponding actions executed during a state transition.

There are five primary states (Figure 3a) and five secondary states (less than 5% of the conversations mapped) (Figure 3b). The system waits in State 1 at the start of each call as well as between the calls. It remains in State 1 unless relevant listing information is given in the form of a customer utterance.

3.2 Call Pattern

Each DA call proceeds through a logical sequence of events and ends with a result from one of six possibilities. The possibilities and their frequency of occurrence (from 750 mapped conversations) are given in Table 1. The first (i.e., one number given out) call pattern was divided into subpatterns and analyzed for differences in call duration and event numbers. There was no significant differences between the subpatterns (P=0.05).

CALL PATTERN ID	CALL PATTERN DESCRIPTION	%
1	One Number Given Out	77.6
2	No number given out	11.9
3	Multiple numbers given out	3.5
4	Intercept call results	3.2
5	Dial instruction for out of state calls	2.0
6	Others (repair, wrong # etc)	1.8

Table 1. Type of call patterns according to result and frequency of occurrence of each

Start/Stop States	Description of Operator Task	Frequency (DA calls)
1 to 1	Call Announcements given at the start of the call	733
1 to 1	Farewell greeting	110
1 to 2	Accept name pronunciation as partial listing information	51
1 to 2	Accept location as partial listing information	293
1 to 3	Accept name and location information and begin listing search	281
2 to 2	Unclear name pronunciation, request spelling info. before search	55
2 to 3	Accept name information to complete listing info., begin search	375
2 to 3	Accept customer positive acknowledgment and search for listing	139
3 to 2	Inconclusive search results, request name spell	144
3 to 3	Search found one listing with close name, request name confirm	213
3 to 3	Search found one listing with multiple numbers, request selection	80
3 to 3	Accept and ignore extraneous statements suggested by customer	147
3 to 4	Decide to give tel. number without customer confirmation	307
3 to 4	Accept customer confirmation of listing containing only one #	256
3 to 7	Decision to end search	50
4 to 1	DA call maintenance system completes bill decision and gives #	575
7 to 1	Recognize and accept customer confirm no telephone number ok	91

Table 2: Primary Tasks of the Operator (N= 750 calls)

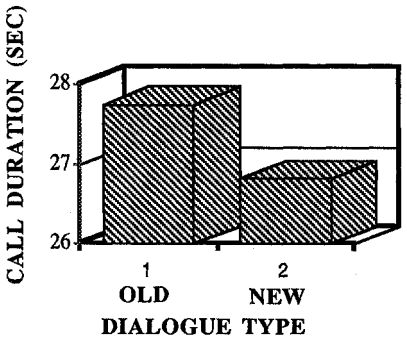

Figure 2. Call Duration for dialogues

3.3 Effect of dialogues on Operator Services

Results of the eight week trial at AGT Ltd showed that the proposed "New" dialogue had a mean call duration of 0.934 seconds lower than the "Old" dialogue (1075 operator man-days; 685,603 DA calls) (Figure 2). Statistical analysis showed that the means of the two dialogues are not statistically different (P=0.40). The mean call duration of "Old" dialogue was 27.8 seconds (SD=5.2 sec; N=321K calls) and the mean call duration of the "New" dialogue was 26.8 seconds (SD=8.4 sec; N=364K calls).

3.4 Characterization of Operator Services

Characterization of Operator-Customer dialogues was undertaken to identify the major tasks of the DA operators. By identifying the major tasks, it was possible to choose the best DA task for a potential Automatic Speech Recognition (ASR) application. ASR systems in Operator Services have useful applications (3,4,5,6). Prior research demonstrates that for successful ASR applications in Operator Services area, careful attention must be paid to dialogue design between the ASR system and human users (7,8). This research has helped AGT Limited understand DA customer dialogue. A tool (DA-SM) has been developed to monitor Operator-Customer dialogues.

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V REFERENCES

(1) J.Baker. "The DRAGONDICTATE^{TM}-30K: Natural language speech recognition with 30,000 words", Proc. European Conf. Speech Com. & Tech., Vol 2, Eurospeech-89, Paris, 1989.
(2) E.Yourdon. "Modern structured analysis", pp. 259-274, 1989.
(3) M.Murphy, K.Read, G.Bielby, A.O'Gorman, B.Roe, and M.Lennig. "Automation of alternate billed calls using speech recognition". IEEE Communications Mag. pp. 25-29, 1991.
(4) Wilpon, J.G., and R.L.Rabiner. "On the recognition of isolated digits from a large telephone customer population". B.S.T.J., Vol 61, No.7, pp. 1977-2000, Sept. 1983.
(5) B.Chigier. "Rejection and keyword spotting algorithms for a Directory Assistance city name recognition application". ICASSP, 1992.
(6) Creitz, W.W. "Applications for voice processing technology", Stoneridge Tech. Services, Box 1891, Rockville, MD 20849, pp. 79-112.
(7) D.Karis, and K.M.Dobroth. "Automating services with speech recognition over the public switched telephone network: Human factors considerations". IEEE J. Selected Areas of Communication, pp.574-585, 1991.
(8) J.Rubin-Spitz, and D.Yashchin. "Effects of dialogue design on customer responses in automated Operator Services". Speech Tech. pp. 126-129, 1989.

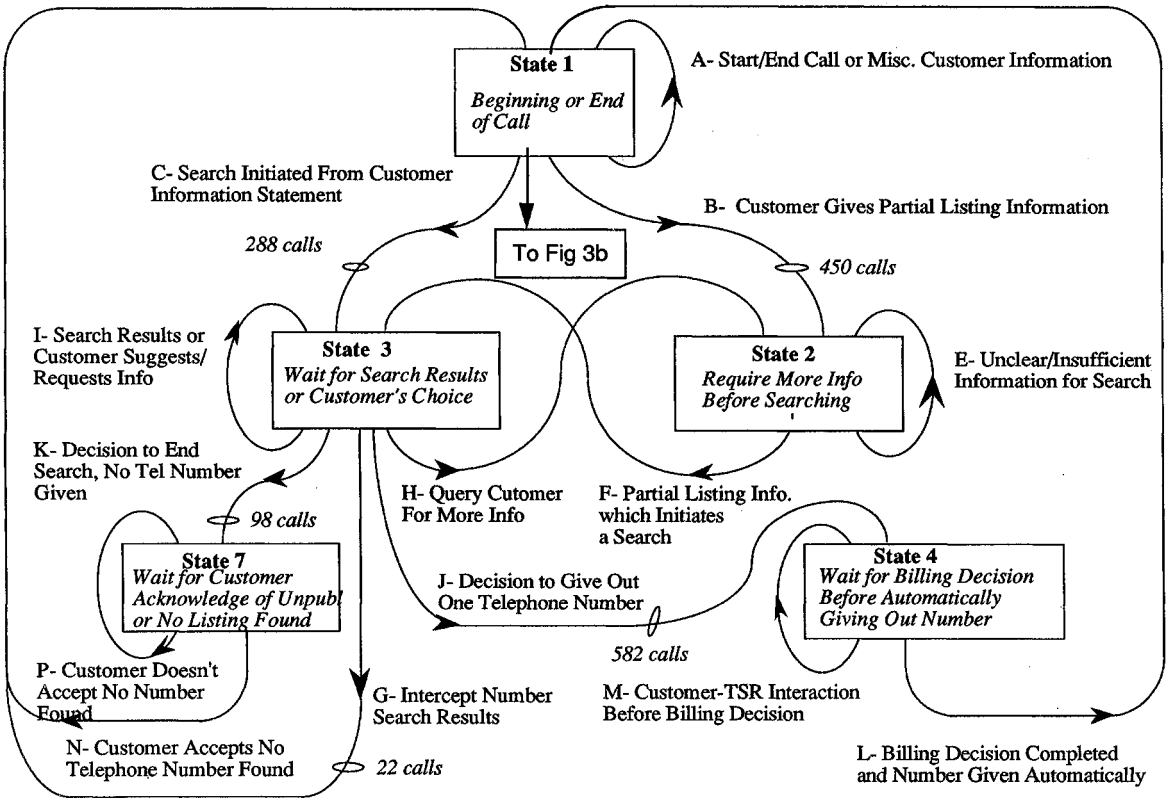

Figure 3a: Directory Assistance State Model Diagram of Primary States

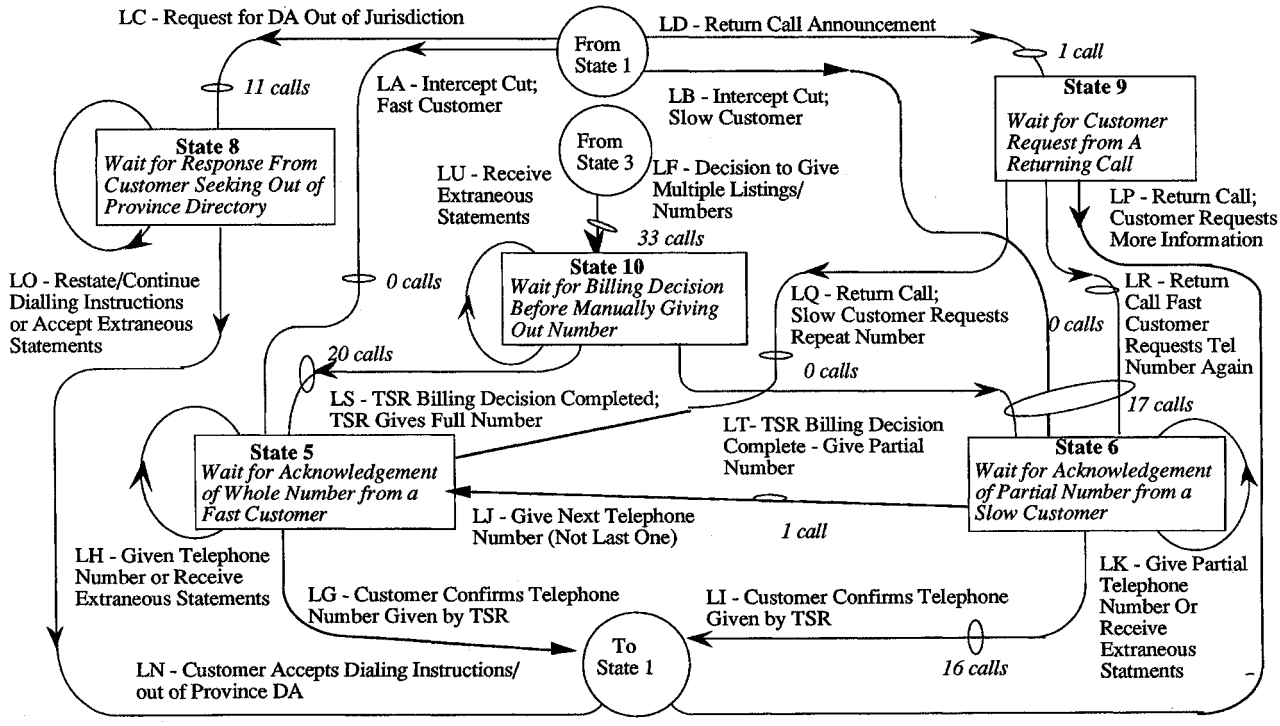

Figure 3b: Directory Assistance State Model Diagram of Secondary States