FIRE INVESTIGATION ORIGIN DETERMINATION SURVEY

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ABSTRACT
The fire investigation industry is considered to be lagging behind the rest of the forensic science fields in its assessment of the performance of methodological approaches and conclusions drawn by practitioners within the field. Despite the best efforts of certifying bodies and industry members, there are still many unknowns within the profession. As such, the researchers have collected a large survey of demographics to formulate a picture of our industry with regards to experience, age, employment, training, and opinions regarding methodology within the industry. In addition to these demographics, the researchers collected data regarding area of origin determination both with and without measurable data (depth of char, calcination) to evaluate its effectiveness when applied without an on-site scene examination. This permitted the comparison of the demographics and accuracy in determining the most important hypothesis in fire investigations, the area of origin. It is shown that 73.8% of the participants without measurable data and 77.7% with measurable data accurately determined the area of origin. Thus, the total percentage of participants choosing the correct area increased 3.9% with the inclusion of measurable data as part of the given. Additional selected outcomes from this research are presented within this paper.

INTRODUCTION
Eastern Kentucky University's Fire and Safety Engineering Technology program currently confers the only Bachelor of Science Degree in Fire, Arson, and Explosion Investigation in the world. With respect to that, the researchers noted that there was limited information available on the demographics of this particular field. While standards exist for the certification and competency of personnel in our profession, there is no record of how well they have been enforced and/or whether the standards accurately portray the requirements needed to adequately perform this job. A multi-part survey was conducted to assess the demographics of the profession and assess accuracy in origin determination.

The main body of the research focuses on determining the success of practicing fire investigators at accurately identifying the area of origin for a fire based on the photographic evidence and measurable damage accumulated from a research burn. One aspect of this research is to evaluate if the use of physically measurable damage in a post flashover fire scene analysis will result in a greater degree of success regarding origin determination compared to relying solely on the visible damage.

BACKGROUND
In relationship to a demographics comparison, a survey performed by the Technical Working Group for Fire and Explosions (TWGFEX) in the year 2000 collected similar demographic data from 422 participants (out of 1400 surveys).[1] Comparisons of the results indicate a marked resemblance to the results of the current survey. While both surveys differed in their proposed purposes, baseline comparisons would help to confirm the distributions seen in this survey. TWGFEX reported an average age of 44.3 years and found the gender distribution to be 96.7% male and 3.3% female. Education levels were similar to the findings of the FIODS survey reported on here with a total of 26.1% high school educated, 26.5% with Associate's degrees, 36% with Bachelor's degrees, 6.6% with Master's degrees,

and 0.7% with advanced degrees. The main demographic difference appeared to be the employer type as TWGFEX had a much larger percentage of participants employed by law enforcement. Either way, TWGFEX reported that over 90% of the survey respondents were directly involved in fire investigation which allows the survey results to be compared.

Reviewing studies from a methodological standpoint revealed three exercises (performed in 2005 and 2008) completed in conjunction with a training seminar to analyze burn pattern development in post-flashover fires.[2,3,4] These exercises focused on the impact of ventilation on fire patterns and the ability of fire investigators to use fire patterns to determine the area of origin. The room was divided into four quadrants and the participants were asked to identify the quadrant in which they believed the fire originated based on visual identification alone. The study reports a 5.7% accuracy rate in attendees determining the correct quadrant of origin. Neither exercise provided the demographics of the attendees, nor does the author imply that the exercise can stand up to any statistical rigor. Nevertheless, Carman attributed the failure to the lack of understanding by the investigation profession of the differences between pre- and post-flashover fire behavior.

METHODOLOGY

In order to get a representative sample of the fire investigation profession, a multi-part survey was developed and administered to the community. As this was the first major survey of this type to be undertaken for the fire investigation field, a wide variety of questions were posed to the participants. The first part of the survey related to demographics, education levels, continuing education participation, certifications, and other items related to the aforementioned topics. As an addition to this aspect of the survey, a number of questions regarding safety on the fire scene and generally held opinions on the industry were posed. The second step of the survey consisted of a pattern identification exercise. Participants were presented with a single photograph of a post-fire scene and asked to identify which fire patterns and fire effects they identified in the photograph. In addition to the list of accepted patterns recorded in NFPA 921, several fire patterns related to myths and pseudo-science were included as possible selections. In the third step of the survey, participants were provided with a set of photographs and a diagram from a post-fire scene and asked to review the contents in order to determine the origin as best as possible. Additional questions regarding the confidence level and methodology were posed as well. The final step of the survey consisted of the same set of photographs and diagram from the third step with measurable data included. The data provided consisted of depth of calcination for all four walls and depth of char for all pieces of furniture in the room. No on scene time was provided to any participant of the survey and all surveys were completed totally online with no contact with the survey administrators being permitted. Due to space limitations, it is not possible to provide all survey questions and other provided information in this paper. However, these items can be accessed online at: jsnet.eku.edu/frp

As discussed previously, there was no baseline information to use for dissemination to ensure a representative sample. As such, personal contacts, message boards, and e-mail blasts from both the International Association of Arson Investigators (IAAI) and the National Association of Fire Investigators (NAFI) were used to distribute the survey. Participants were provided a link to the completely online survey. During the completion of the survey, they were also provided detailed instructions on completion and assurances that all responses would be kept confidential. Based on the stated membership levels of these two organizations, the researchers estimate the fire investigation profession to consist of approximately 8,000 professionals. The researchers felt that this method of dissemination would adequately reach the majority of those active in the fire investigation field. The results of the survey indicated a population of respondents that were both highly educated (75% held some kind of college degree) and highly experienced (over 50% had been lead investigator on more than 100 fires). This lends credence to the methodological aspect of this survey.

There are several noted limitations within this survey. Since there has been little demographical research in the fire investigation profession, there is no way to ensure the representativeness of the sample of this survey. However, the sheer sample size of approximately 600 vs. the population of around 8,000 (estimated from membership numbers provided by IAAI and NAFI) provides an adequate portrait of the industry. Comparisons with the earlier mentioned TWGFEX survey also help to confirm the validity of the results of this survey. Secondly, the method of dissemination was not controlled in this instance. In other words, the survey was sent out through a variety of agencies with the researchers having no control over who completed the survey. Finally, there have been concerns expressed regarding the likelihood of individuals to complete the survey. Certain demographics may have been apprehensive to complete the survey as they feel it may have reflected poorly on their specific skills/education/background/etc. Even though all efforts were made to protect the particular identities of all individuals in the survey, this is still a valid concern.

RESULTS AND DISCUSSION

Demographics

While it was unable to determine the precise number of participants invited, a total of 586 responses to the survey were received. The sample was mostly male (96%) with an average age of 46 years (SD=10.8). The average experience as a full time investigator was 10.5 years (SD=9.4). Nearly two thirds were public investigators (65%) and the remaining were privately employed. Of the public investigators 54% were employed by fire departments, 14% were law enforcement, 9% were from fire prevention bureaus, and the remaining 5% were employed by "other" agencies. In addition over 78% had worked as a firefighter at some point in their career. Of the individuals indicating they had experience as a firefighter, 62% had been paid, 40% had been volunteer, and 11% had been paid on call. Figures 1 and 2 and Tables 1 thru 6 contain an overview of some selected additional demographics obtained through the survey.

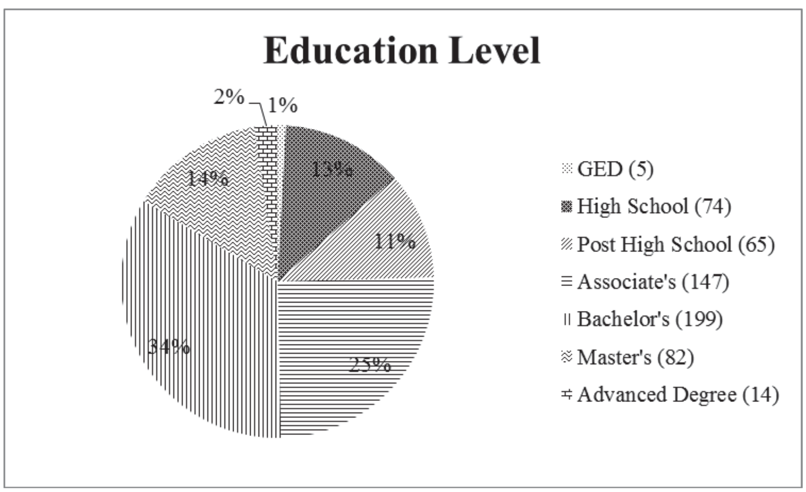

Figure 1: Education Level (Total responses listed in key)

Table 1: Area of Degree Study

Area of Study	Number	Percentage
Fire Science	210	35.7%
Criminal Justice	82	13.9%
Fire Protection Engineering	47	8.0%
Electrical Engineering	24	4.1%
Mechanical Engineering	19	3.2%
Other Engineering	16	2.7%
Public Administration	23	3.9%
Forensic Science	4	0.7%
Other	161	27.4%

Table 2: Certification Levels

Certification	Total	Percentage	Certification	Total	Percentage
Firefighter I	383	65.0%	Fire Officer II	149	25.3%
Firefighter II	330	56.0%	PI	98	16.6%
CFEI	324	55.0%	CVFI	93	15.8%
Haz Mat Operations	293	49.7%	IAAI-FIT	85	14.4%
Fire Instructor I	276	46.9%	CFII	64	10.9%
HazMat Awareness	271	46.0%	PE	31	5.3%
HazMat Technician	270	45.8%	CFO	21	3.6%
Fire Inspector I	261	44.3%	CFPS	20	3.4%
Fire Officer I	213	36.2%	EFO	14	2.4%
IAAI-CFI	179	30.4%	IAAI-CI	8	1.4%
Fire Inspector II	166	28.2%	ATF-CFI	6	1.0%
Fire Instructor II	155	26.3%	IAAI-ECT	5	0.8%

Table 3: Professional Organization Membership

Organization	Total	Percentage	Organization	Total	Percentage
IAAI	516	87.8%	ASTM	20	3.4%
NAFI	389	66.0%	ICAC	14	2.4%
NFPA	247	41.9%	IFE	11	1.9%
IFMA	41	7.0%	AAFS	6	1.0%
SFPE	35	5.9%	ACJA	1	0.2%
IABTI	26	4.4%	IFSFI	0	0.0%

Table 4: Journal Readership

Journal	Total	Percentage
Fire and Arson Investigator	493	83.8%
National Fire Investigator	334	56.7%
Firehouse	277	47.0%
Fire/Rescue	180	30.6%
Fire Technology	177	30.1%
Fire Protection Engineering	112	19.0%
Journal of Fire Protection Engineering	45	7.6%
Fire Safety Journal	32	5.4%
Journal of Forensic Science	24	4.1%
Fire Risk Management	16	2.7%
Journal of the National Academy of Forensic Science	7	1.2%

Table 5: Conference Attendance

Conference	Total	Percentage
IAAI State Chapter Training	335	56.9%
Any National Fire Academy Course	216	36.7%
Public Agency Training Council	207	35.1%
IAAI Annual Training Conference	169	28.7%
NAFI/NFPA National Training Seminar	137	23.3%
Technical Working Group on Fire and Explosions	64	10.9%
NFPA Conference and Expo	54	9.2%
ISFI	52	8.8%
Federal Law Enforcement Training Center	38	6.5%
ICAC Fire and Arson Invesitigation Seminar	10	1.7%

Table 6: Online Training Participation

Training Provider	Total	Percentage
CFI Trainer	500	85.0%
Pennwell Fire Engineering	24	4.1%
UL University	20	3.4%
Fire Protection Engineering	16	2.7%

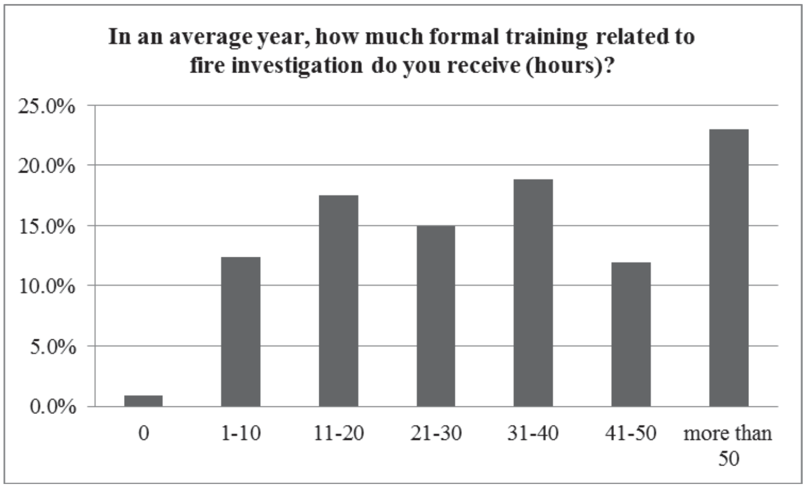

Figure 2: Annual Training Hours

The education level of fire investigators responding to the survey was remarkably high with over 75% of the respondents holding at least an Associate's degree. Also notable was the frequency of certifications. Over 79% of the respondents held at least one certification directly related to fire investigation and nearly 100% were a member of at least one professional organization. Journal readership was also staggering with nearly 100% reading at least one industry journal. Also, the market saturation of the IAAI's CFI Trainer is worth noting with 85% of the respondents reporting to have used the online training tool at some point. Finally, the self-reported formal training hours show an industry that actively educates itself with the majority of participants receiving a minimum of 20 hours of continuing education per year.

Initial Opinions

As part of the demographics portion of the survey, the researchers posed a series of questions regarding the participant's opinion on a variety of topics relating to the fire investigation field. Figures 3 thru 19 contain a visual display of this information.

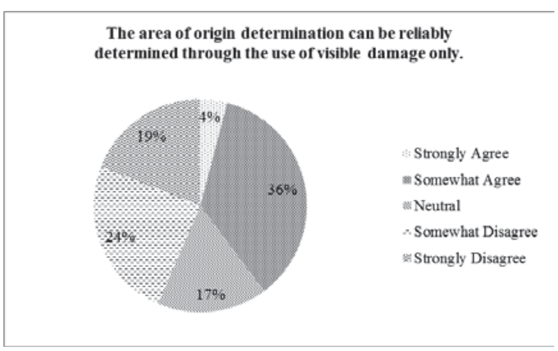

Figure 3: Visible Damage Use

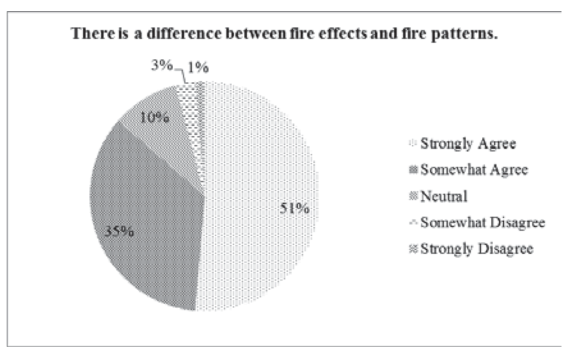

Figure 4: Effects vs. Patterns

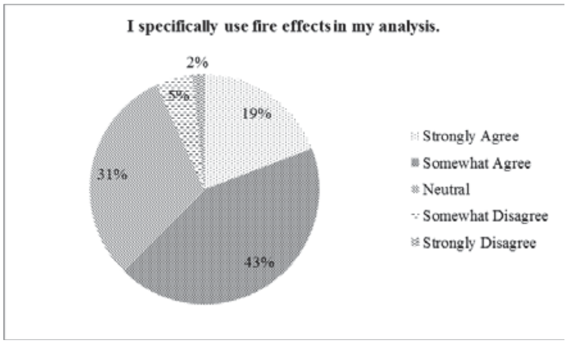

Figure 5: Fire Effect Use

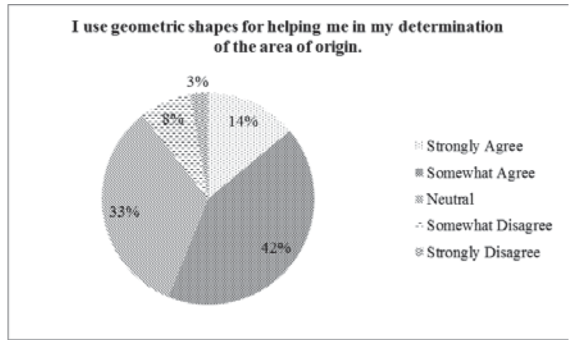

Figure 6: Geometric Shape Use

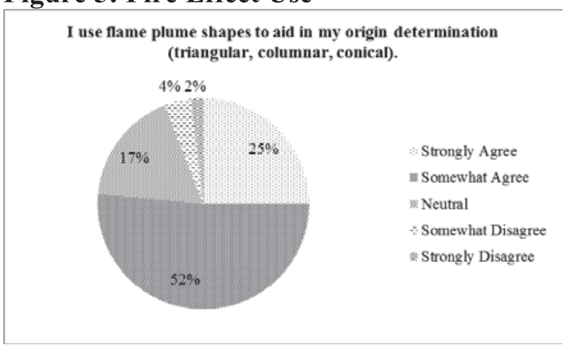

Figure 7: Flame Plume Shape Use

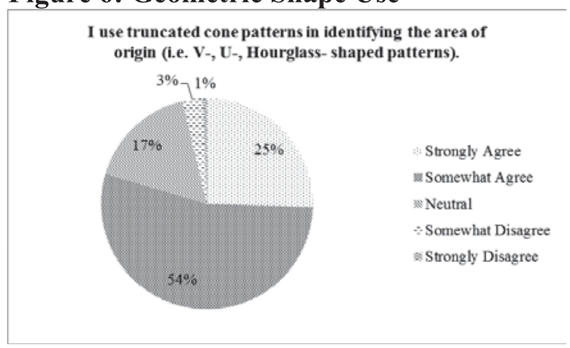

Figure 8: Truncated Cone Pattern Use

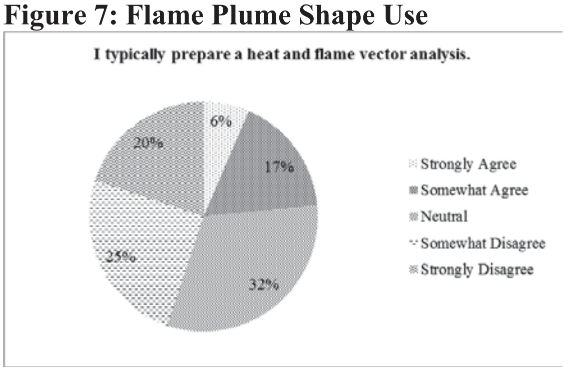

Figure 9: Heat and Flame Vector Use

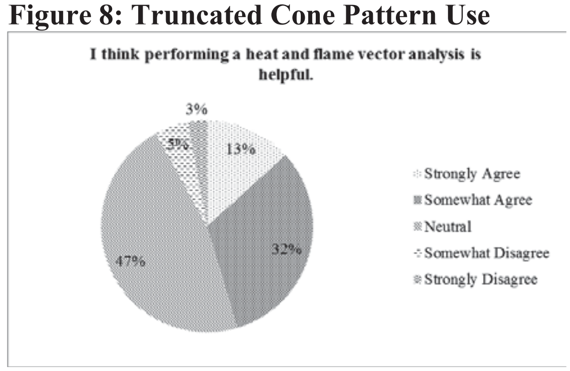

Figure 10: Heat and Flame Vector Opinion

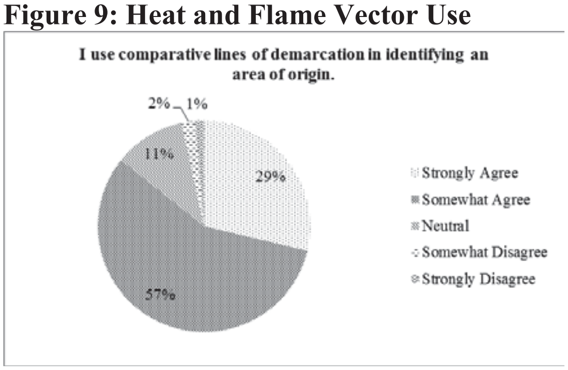

Figure 11: Lines of Demarcation Use

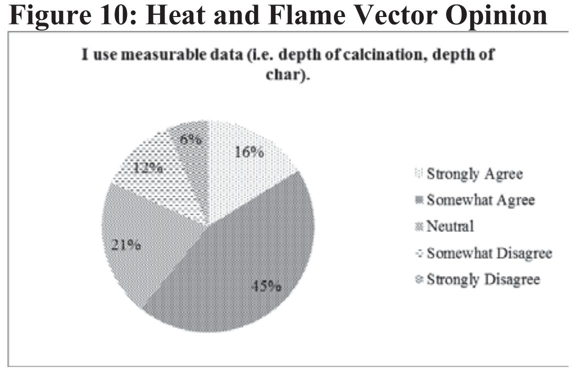

Figure 12: Measurable Data Use

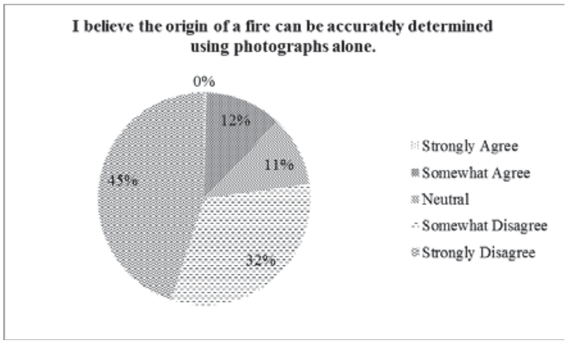

Figure 13: Photographs Only Opinion

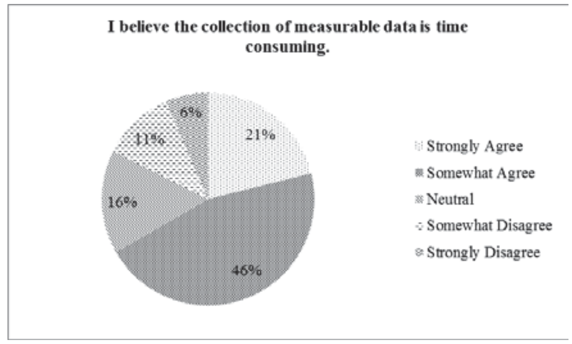

Figure 14: Measurable Data Use

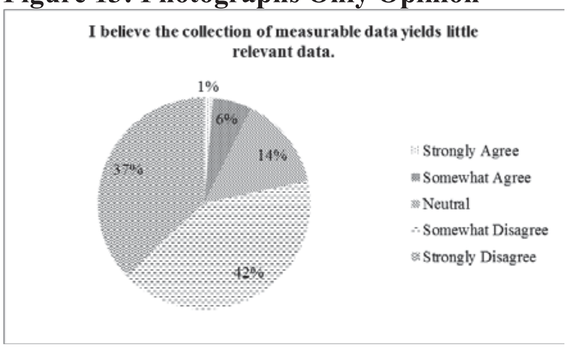

Figure 15: Measurable Data Opinion

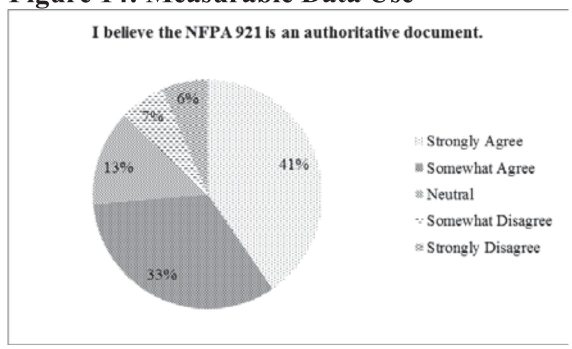

Figure 16: NFPA 921 Opinion

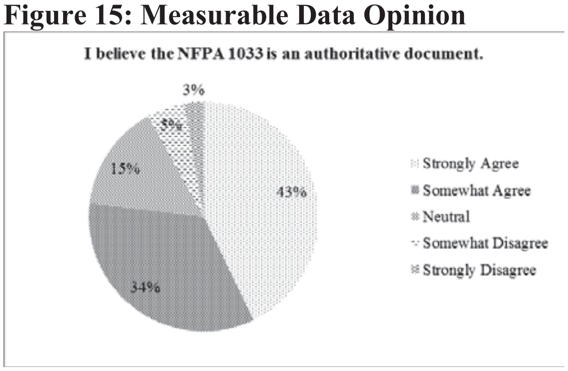

Figure 17: NFPA 1033 Opinion

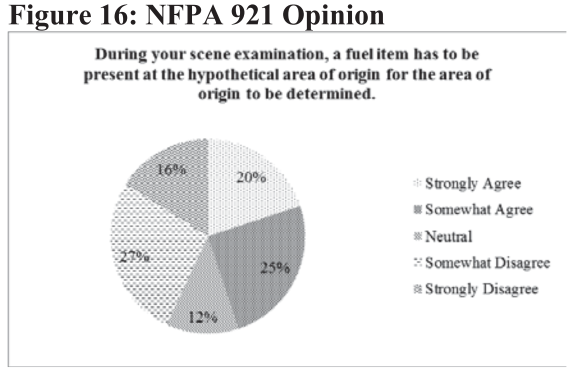

Figure 18: Fuel Item Presence

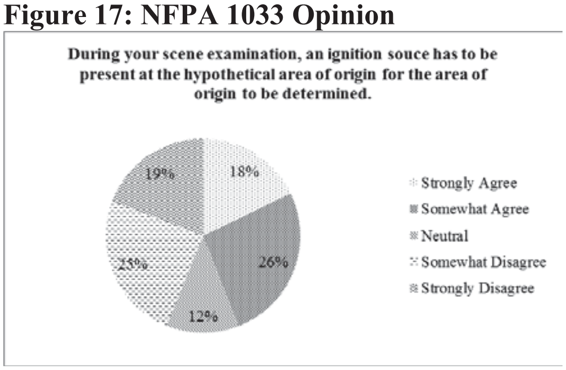

Figure 19: Ignition Source Presence

These questions were posed to formulate a general idea of how the industry feels regarding certain methodological and legal aspects of the profession. By far, the most interesting results of these questions were the fact that only 73.6% and 76.9% of the participants believe NFPA 921 and NFPA 1033 to be authoritative, respectively. The presence of these documents within the industry for the past 20 years, the general acceptance of these standards of care by both NAFI and IAAI for the past 12 years, and the consistent acceptance of these documents by the legal industry warranted a higher response rate to these questions.

Pattern and Effect Recognition

As stated previously, the second portion of the survey consisted of the presentation of a single photograph (Figure 20) and posed a series of questions regarding an investigator's ability to recognize and interpret fire effects and fire patterns. The data in Tables 7 and 8 provide the number and percentage of participants that identified the fire effect or pattern observed in the photograph, as well as illustrating whether or not this particular effect or pattern was actually present. Figure 21 shows the results of asking the participants to interpret a direction of fire movement if one could be determined from the observed effects and patterns.

Figure 20: Photograph for Pattern and Effect Recognition

Table 7: Identified Fire Effects

Fire Effect	Number	Percentage	Present?
Smoke Deposition	535	91.0%	Y
Melting	501	85.2%	Y
Char	497	84.5%	Y
Color Changes	444	75.5%	Y
Mass Loss	426	72.4%	Y
Clean Burn	422	71.8%	Y
Thermal Expansion	329	56.0%	N
Oxidation	280	47.6%	N
Shiny Char	152	25.9%	N*
Collapsed Furniture Springs	129	21.9%	N
Spalling	94	16.0%	N
Pour Pattern	74	12.6%	N*
Calcination	73	12.4%	N
Rainbow Effect	31	5.3%	N
Distorted Lightbulbs	4	0.7%	N
Victim Injuries	2	0.3%	N
Window Glass	0	0.0%	Y

*Not an accepted fire effect per NFPA 921 and has been associated with myths

Table 8: Identified Fire Patterns

Fire Pattern	Total	Percentage	Present?	Fire Pattern	Total	Percentage	Present?
Triangular	41	7.0%	N	Circular	48	8.2%	N
Columnar	46	7.8%	N	Radial	51	8.7%	N
Conical	60	10.2%	Y	Irregular	136	23.1%	N
V-pattern	422	71.8%	Y	Donut	7	1.2%	N
Inverted Cone	66	11.2%	N	Linear	28	4.8%	N
Hourglass	17	2.9%	N	Area	87	14.8%	N
U-shape	60	10.2%	N	Saddle Burns	10	1.7%	N
Truncated Cone	50	8.5%	Y	None	30	5.1%	N
Pointer and Arrow	52	8.8%	N				

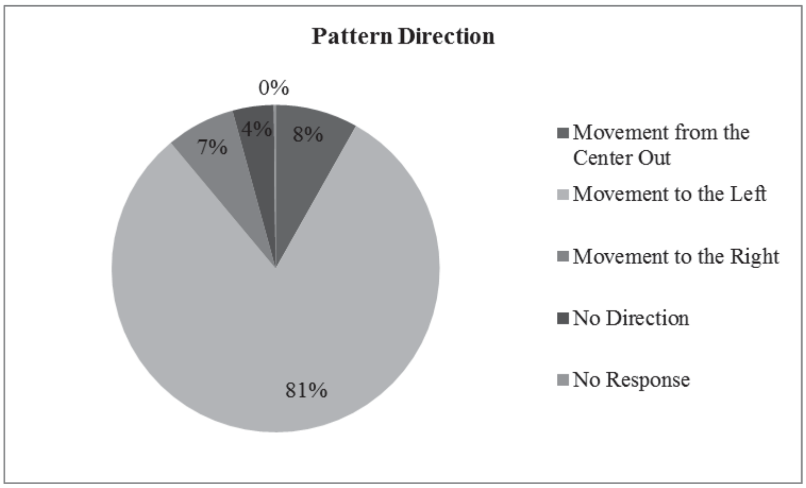

Figure 21: Pattern Direction (Movement to left correct answer)

The results of the fire effect identification demonstrated some glaring problems within the industry. There were several effects deemed not present by the researchers that were identified by a relatively high number of participants. In addition, several participants identified effects purposefully included as "myths" and pseudo-science that have been specifically targeted in industry texts for the past twenty years as being erroneous. These included shiny char and pour patterns. Pattern recognition also showed a significant number of individuals identifying patterns that were not present in the photograph. The identification of the direction of fire movement showed that the majority of participants identified the correct direction. However, 15% of the respondents misidentified the movement direction.

Origin Determination

The third part of the survey consisted of a scene diagram and a series of photographs from a post-fire investigation. The full-scale compartment fire test that was conducted as part of this survey took place in a room with features resembling a typical apartment. The apartment was constructed within the "test burn building" at Eastern Kentucky University with a front room resembling a living room and a back room resembling a bedroom. The living room is 4.87m wide by 4.27m long (~16'W x 14'L) with a front door and front window 1.07m wide by 0.91m high (~3'6"W x 3'H); a bedroom 3.96m wide by 4.57m long (~13'W x 15'L) with a side hallway doorway and rear window 1.07m wide by 0.91m high (~3'6"W x 3'H); and a rear hallway 0.91m wide by 4.88m long (~3'W x 16'L) adjacent to the bedroom on the right and leading to a rear exterior door. Exterior doors are 0.99m wide by 2.21m high (3'3"W x

7'3"H). All experiments utilized single pane glass windows. No fuel was placed in the bedroom portion of the apartment (Figure 22).

This test lasted for approximately 13 minutes and 20 seconds with the window failing around 570 seconds, flashover occurring around 720 seconds, and the extinguishment at approximately 780 seconds. Flashover was determined visually by the ignition of the carpet inside the doorway and by the presence of flaming combustion exterior of the compartment through the window and doorway. This timing was confirmed by two technical indicators for flashover, an upper layer temperature of 600°C and a heat flux of 20 kW/m^2 at the floor level. Temperatures were in excess of 300°C at 1-2 feet above the floor for approximately 500 seconds. Heat flux values at the floor were found in excess of 70 kW/m^2 for approximately 70 seconds. These readings may be slightly higher due to the proximity of the heat flux transducer to the initial fuel items. Figures 23 and 24 show the post-fire damage to the living room area of the apartment.

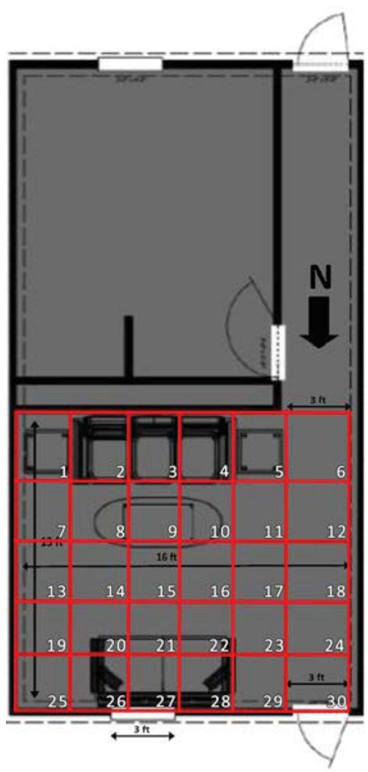

Figure 22: Grid Layout

Figure 23: Post Fire Damage

Figure 23: Post Fire Damage

A series of questions were asked of the participants in order to determine where he/she believed the origin to be located. Figure 22 shows the grid pattern provided to the survey participants. Each grid was approximately 2 square feet. The actual area of origin was in Grid 5 under the end table. Note that this scenario was chosen due to the fact that the pictures should have led the investigator to Grid 4 (the right side of the sofa) while the measurable data should have provided enough information to move the origin to the correct grid. The results of the origin determination can be found in Table 9 and the confidence levels of the participants are summarized in Table 10. Note that a total of 78 (13%) participants changed their area of origin after receiving the measurable data.

Table 9: Origin Grid Results

	Without Measurable		**With Measurable**	
	Total	**Percentage**	**Total**	**Percentage**
Grid 1	5	0.9%	5	0.9%
Grid 2	7	1.2%	9	1.5%
Grid 3	90	15.3%	72	12.3%
Grid 4	293	49.9%	343	58.4%
Grid 5	140	23.9%	113	19.3%
Grid 18	12	2.0%	8	1.4%
Grid 27	16	2.7%	13	2.2%
Other	24	4.1%	24	4.1%

$\chi^2_{(7,N=587)}$=19.81, p=.006

Table 10: Confidence in Determination

	Without Measurable		With Measurable	
	Total	Percentage	Total	Percentage
25%	36	6.1%	25	4.3%
50%	105	17.9%	77	13.1%
75%	334	56.8%	315	53.6%
100%	106	18.0%	167	28.4%

$\chi^2_{(7,N=587)}$=47.01, p<.001

The majority of the participants (89.1% without and 90% with measurable data) chose either grid 3, 4, or 5. Using the assumption that either grids 4 or 5 are within an acceptable boundary for an accurate area of origin, it can be shown that 73.8% of the participants without measurable data and 77.7% with measurable data accurately determined the area of origin. Thus, the total percentage of participants choosing the correct area increased 3.9% with the inclusion of measurable data as part of the given. These results were found to be statistically significant using a chi square distribution yielding a p-value of 0.006. Table 10 shows the confidence intervals chosen by the participants both with and without measurable data. Again, the differences shown in this table were found to be statistically significant indicating that the inclusion of measurable data made an improvement in the amount of confidence the participant had in their area of origin selection.

After the determination of the origin, both without measurable data and with measurable data, the participants were asked to weight the values placed on individual aspects of the investigation. The results can be found in Figures 25 thru 31.

Interesting to note here is that measurable damage to contents was provided the highest value in the consideration for the area of origin determination (82.0% of the participants rating 4 or 5), followed by visible damage to contents (79.3%) and greatest degree of damage (77.4%). It should be observed that these fire effects are ones that contain the most uncertainty when used in post-fire analysis.[5]

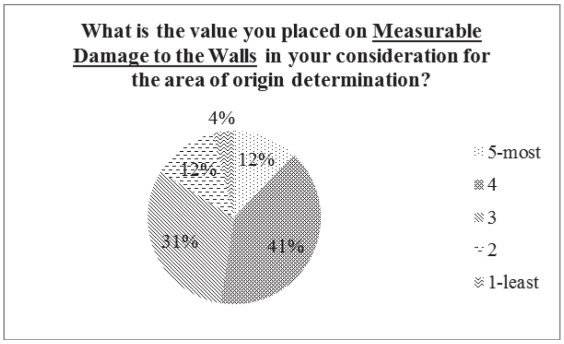

Figure 25: Measurable Damage Value (Walls)

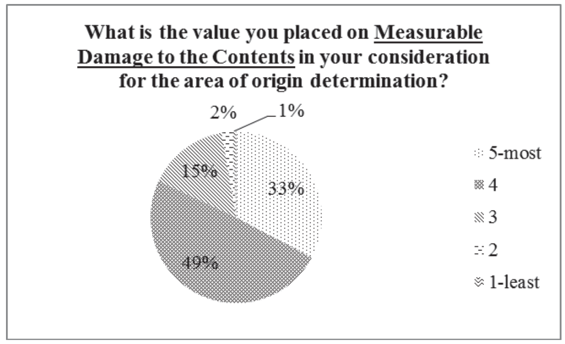

Figure 26: Measurable Damage Value (Contents)

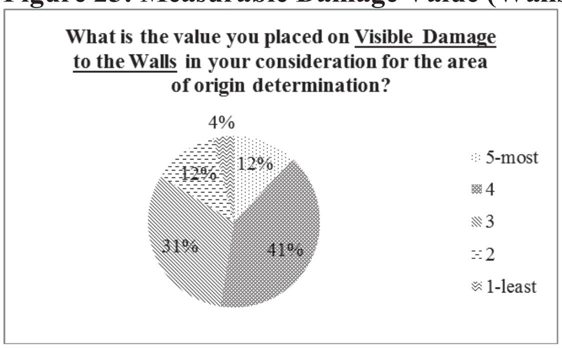

Figure 27: Visible Damage Value (Walls)

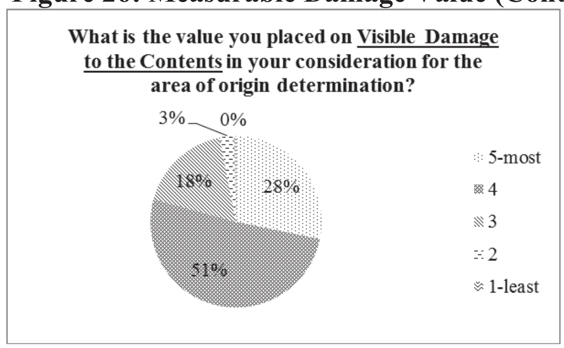

Figure 28: Visible Damage Value (Contents)

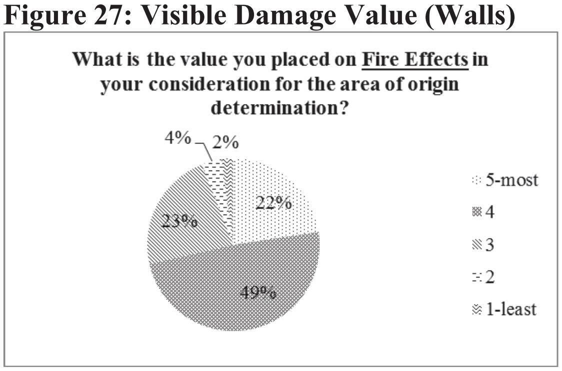

Figure 29: Fire Effects Value

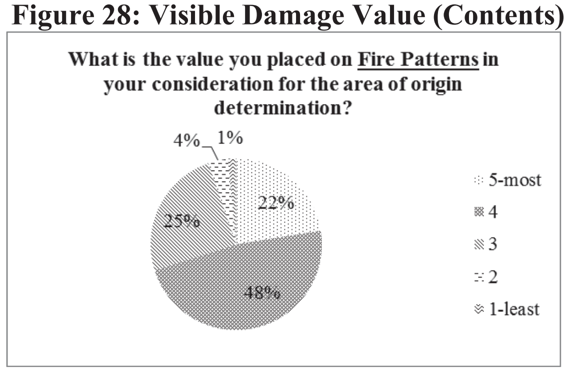

Figure 30: Fire Pattern Value

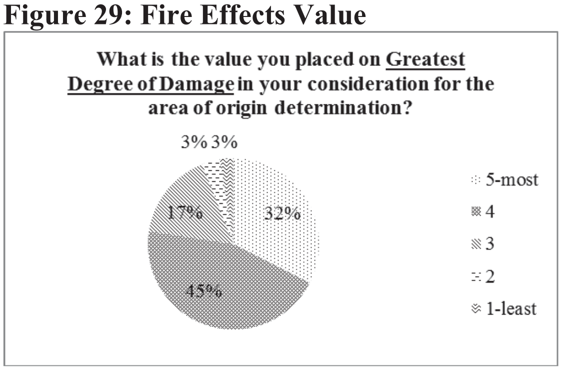

Figure 31: Degree of Damage Value

Relationships

Using the data derived from the survey, a number of relationships were examined in order to analyze the effects of certain demographic and methodological factors on the likelihood of determining the correct area of origin. Based on the proximity of the fuels and resulting damage, the researchers determined that an acceptable boundary for an accurate area of origin included both grids 4 and 5 as the correct answer. This works under the assumption that when it comes time to narrow the area of origin to the correct grid, it would be largely dependent on further scene processing which would include locating a competent ignition source, eventually leading the investigator to grid 5. As such, the remaining figures in the paper will consider an answer of either grid 4 or grid 5 to be correct.

Table 11 demonstrates the results of a number of questions in a comparative fashion. The total responses column alludes to the participant's level of agreement with the question "I believe the origin of a fire can be accurately determined using photographs alone." The average confidence describes the confidence that participants placed on their area of origin determination when made with photographs alone. The accuracy refers to the number of participants reaching the correct area of origin. The most interesting aspect of these figures is the individuals with less confidence in the use of photographs alone tended to have both a lower level of confidence and a lower level of accuracy. Another interesting point is that even though individuals rated they strongly disagreed with the determination of origin based solely on photographs, they still had an average confidence level of nearly 69%. Also interesting to note was the contradiction made by the majority of the participants between the third portion of the survey (photographs alone) and the first part of the survey. 77.2% of the participants agreed that you cannot determine an area of origin based on photographs only, yet when asked to do just this for the survey the majority of the participants (74.8%) provided a confidence level of 75% or greater in the determination when provided only photographs.

Table 11: Confidence and Accuracy

	Total Responses	Average Confidence	Accuracy
Strongly Agree	24	74.0%	79.2%
Somewhat Agree	210	73.3%	73.8%
Neutral	98	72.4%	78.6%
Somewhat Disagree	144	69.1%	75.0%
Strongly Disagree	112	68.9%	66.1%

The next relationship consisted of a comparison of the primary method of origin determination versus the likelihood an individual was to arrive at the correct fire origin (Table 12). Several interesting trends were noted in this data. First of all, and perhaps most surprising, no participant placed the highest weight on the greatest degree of damage which is counter to the study performed by Steve Carman.[2,3,4] The lowest performing participants were the ones who placed a high weight on fire patterns alone. The prominent use of either fire effects or heat and flame vector analysis provided more accurate results. These differences were found to be statistically significant with a p-value well under .001, both with and without measurable data. The researchers believe this to be due to the fact that those participants that evaluated fire effects and/or used a heat and flame vector analysis would include the analysis of individual effects on a one on one basis. Without the elementary analysis of effects prior to the grouping of them into patterns, it is shown that the participant is less likely to reach the appropriate conclusion. It is believed that the separation of data and the interpretation of the data may be a reason for the significant difference.

Table 12: Primary Consideration vs. Accuracy

		Without Measurable		With Measurable	
	Total Responses	Number	Percent	Number	Percent
Fire Effects	314	248	79.0%	258	82.2%
Fire Patterns	224	148	66.1%	159	71.0%
Heat and Flame	48	37	77.1%	38	79.2%
Greatest Degree	0	0	N/A	0	N/A

Without: $\chi^2_{(3,N=586)}=54.31$, $p<.001$ *With:* $\chi^2_{(3,N=586)}=32.08$, $p<.001$

Another interesting comparison was demonstrated by comparing the identified direction of movement from part 2 of the survey with the accuracy in the third and fourth parts (Table 13). Individuals who correctly identified the direction of movement demonstrated a higher accuracy than individuals who did not. The interesting part was that respondents who refused to assign a direction of travel were equally as accurate. The researchers believe this to be also connected to the separation of data and the interpretation of data. Those that chose to not provide a direction were probably resistant to doing so without evaluating the totality of damage.

Table 13: Direction of Movement from Single Photograph vs. Origin Determination Accuracy

		Without Measurable		With Measurable	
	Total in Category	Number	Percent	Number	Percent
Movement to Left	475	356	74.9%	376	79.2%
Movement to right	40	24	60.0%	26	65.0%
No Direction	24	17	70.8%	19	79.2%
Movement from Center Out	48	35	72.9%	34	70.8%

Due to space limitations, it is not possible to include an in depth discussion of all demographic factors in this paper. However, some other interesting trends did arise. Accuracy was analyzed with respect to certifications, type of degree, level of education, years of experience, journal readership, conference attendance, and book ownership. The differences observed tested as statistically insignificant; however, the more active an individual was in the field tended to favor a higher accuracy rate. There was not a continuing improvement observed as these values increased. For example, participants with modest access to industry texts had a higher rate of accuracy; there was no significant improvement by owning every text. There were also large improvements seen in individuals who read one journal as opposed to no journals and individuals who attended one conference as opposed to no conferences. The researchers believe this to be an effect of the respondent's interest in the industry. Individuals who read, attend conferences, and keep up with improvements in the industry were shown to be more effective at their job.

CONCLUSIONS

In conclusion, the demographics show an industry that is highly experienced, well educated, and prides itself on continuing education. There is a wide array of participants with a wide array of educational and work backgrounds working in the fire investigation industry. Certification levels and conference attendance could certainly see improvements in the sample surveyed for this exercise. The attendance of conferences is time consuming and costly, but as shown in the study a well-designed conference with an engaged attendee will provide amply reward for the initial investment. If the fire investigation industry wishes to move towards a higher level of professionalism, certification levels will have to increase. Organizations must monitor the requisite skills and knowledge of the profession and individuals should be driven to show their competency.

Methodologically, it is apparent that the collection and provision of measurable data made a statistically significant difference in both the confidence and accuracy of the participants. This indicates that the profession should encourage the collection and documentation of measurable data. It is also apparent that there should be more education/focus on the appropriate recognition of fire effects, the methodology of grouping those effects into patterns, and the interpretation of the movement/intensity indicated by these patterns.

While there was not ample room to report on every single finding in this study, there were multitudes of contradictions in question answers based on the scenario in which they were asked. For instance, it is widely recognized that the greatest area of damage alone cannot be utilized solely for origin determination, but over 77% of the participants rated it as a primary consideration when asked the question outside of the scenario. Once within the scenario, no participants rated it as their primary consideration. It is possible that investigators are trained in the dangers of the use of greatest degree of damage and will not state that it is a major consideration, but will continue to believe it is an effective consideration and apply it in application. The researchers believe this stems from the instructional methods currently utilized by the profession. There are several more instances of similar contradictions noted within the study, but due to space restrictions the researchers will have to release those analyses at a later date

ACKNOWLEDGEMENTS

The researchers would like to thank the almost 600 participants of the survey. This work would have been impossible without the sacrifice of your time. In addition, the funding provided by Eastern Kentucky University's Justice and Safety Research POD Committee must be acknowledged. Thanks to Matt Elswick of the College of Justice and Safety's IT department for his work in developing and maintaining the website which hosted the survey. Finally, it is appropriate to thank both NAFI and IAAI for utilizing their electronic mailing lists as a means of distribution for the survey.

DISCLAIMER

Please note that these results are presented as a tool for the improvement of the fire investigation profession. In no way are the authors endorsing any specific training agencies, certifications, techniques, employment types, or experience levels as better than the other.

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ENDNOTES

1. Results of TWGFEX Scene Survey (2000). Retrieved from http://ncfs.ucf.edu/twgfex/docs/Scene_Survey_Results.pdf
2. Carman, S. *Improving the Understanding of Post-Flashover Fire Behavior*. 2008 International Symposium on Fire Investigation Science and Technology (2008).
3. Carman, S. *Burn Pattern Development in Post-Flashover Fires*. 2009 International Symposium on Fire and Materials (2009).
4. Carman, S. *"Clean Burn" Fire Patterns - A New Perspective for Investigators.* 2010 International Symposium on Fire Investigation Science and Technology. University of Maryland: Maryland.
5. Schroeder, R. (1999). Post-Fire Analysis of Construction Materials. Doctor of Engineering dissertation, University of California, Berkeley.