Proceedings of 20th International Congress on Acoustics, ICA 2010

23-27 August 2010, Sydney, Australia

THE FORTALEZA NOISE MAPPING PROJECT – A TOOL FOR THE STRATEGIES OF KNOWLEDGE AND CONTROL OF NOISE IN THE MUNICIPALITY AND THE NEW PERCEPTION FOR THE CONTROL OF BIG MUSIC EVENTS"

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PACS: 43.50.KI, 43.50.-X, 43.50.RQ

ABSTRACT

The Fortaleza noise mapping project was set up for the spatial representation of environmental noise indicators to obtain an essential tool to analyze and define strategies for Noise Pollution control in Fortaleza, Brazil. This is the first large scale noise map drawn for a large city in Brazil. Noise emissions from the most important sources contributing to the sound environment of the city, namely road traffic, railway noise, aircraft noise, industrial noise, and noise from entertainment areas were included. The method followed a hybrid approach, essentially calculation complemented with experimental measurements for validation and calibration. The large scale noise assessment allowed detailed studies of the noise impact of the Fortaleza International Airport, located well within the urban city area, the impact of the passage of the underground access light rail tunnel on the local soundscape and the impact of the Ceará Musical Event, which, though being part of the city cultural programme, takes place in central and seaside areas close to a public hospital. These studies will be presented and discussed, in the context of a geographical area where the fair climate allows long hours spent outdoors.

INTRODUCTION

Noise pollution control in a large city bears a high degree of complexity with the problems related to an airport within the urban area, to a light rail system in a high density residential area and to large entertainment events taking place in densely populated areas all being a real challenge.

Assuming these difficulties and based on the complex physical structure of the city of Fortaleza, Northeast Brazil, strategies were defined to strategically consider the problem. The Noise Map of Fortaleza was developed as the most appropriate tool for the assessment of such issues. The volumetry of the entire municipality was updated, data related to road traffic, to aircraft movements, to train passages and infrastructure, to industries, to population were all collected and organized in databases. The noise map was drawn, thus establishing a powerful strategic tool for public policies to control the noise in the city.

PROJECT OVERVIEW

The Noise Map

A noise map is a spatial representation of the environmental noise indicators, which in urban areas has proven an essential tool for noise assessment and for defining strategies for noise control. The Noise Map of Fortaleza is intended as a tool for noise reduction and improvement of the quality of the sound environment in the city as a tool for sustainable development and, as such, improving the quality of life.

Noise maps describe the spatial distribution of ambient noise in the entire area of the city of Fortaleza, resulting from emissions of the most relevant sound sources contributing to the sound environment of the municipality, namely:

- Road traffic
- Railway noise
- Aircraft Noise
- Industrial noise
- Noise from entertainment venues
- Other

Implementation methodology

The methodology used for the preparation of the Noise Maps of Fortaleza followed the state of the art. A hybrid method was adopted, essentially following calculations complemented with experimental measurements for validation and benchmarking. The adopted calculation methods were tested and internationally recognized.

The methods underlying the European requirements, were followed in principle, since they are recognized as the most

advanced at international level, as well as the latest guidelines issued by the European Commission and prepared by E.U. Noise Policy Working Group on Assessment of Exposure to Noise. The methodology also takes into account the document "Good Practice Guide for Noise Mapping", in its latest version 2 of August 2007, issued by the European Commission, and prepared by the aforementioned group.

A 3-D acoustic model was built with a set of databases with all the necessary information on land, buildings and the emitting noise sources.

The noise maps show the values of sound levels in 5 dB intervals with color coding in accordance with the Brazilian or international standards (ISO 1996). The maps were produced for the reference periods of day and night. The noise assessment points are placed at the vertices of the mesh considered more appropriate to the characteristics of each study area in the city. Calculations were done using the CadnaA software.

Development of the project

For implementation of the Fortaleza noise map, a team of experts was set-up. A course on noise mapping was organized for everyone involved. A digital map of the city dated of 1996 was used and appropriately updated (see Figures. 1 and 2).

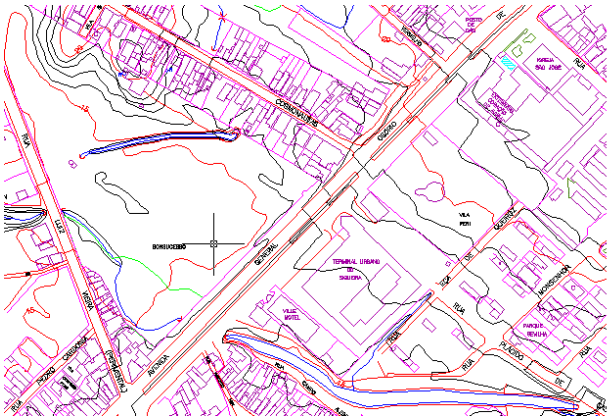

Figure 1. Situation in 1996.

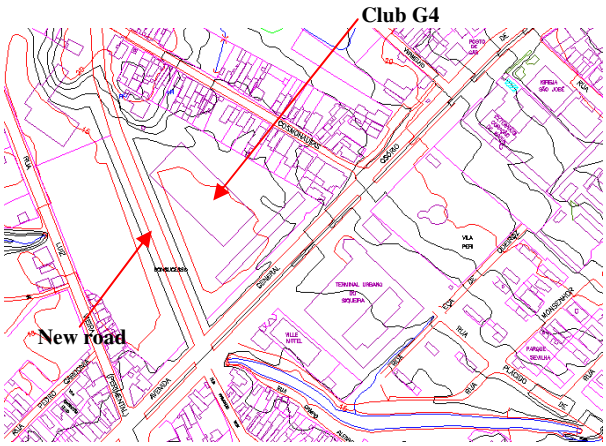

Figure 2. Situation in 2010.

- Further tasks involved: Search the other data necessary for the calculation of the noise map (traffic lights, pavement type, profile of coatings, buildings population, noise sources, number of vehicles on the different roads, air routes, subway, etc.).
- Treat all blocks of the digitized map of Fortaleza in AUTOCAD software and process files
- Import the files into the calculation software.
- Calcule noise maps.
- Individualized study for the Pinto Martins International Airport.

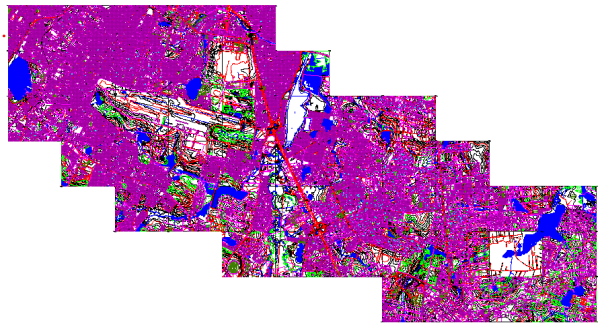

Figure 3. Pinto Martins International Airport and the surrounding neighbourhoods

- Individualized study for the stretch of the Couto Fernandes Station to the entrance of the underground portion of the Subway. On the map shown in the example in Figure 4, the subway passes near a hospital complex and next to a large avenue with high traffic.

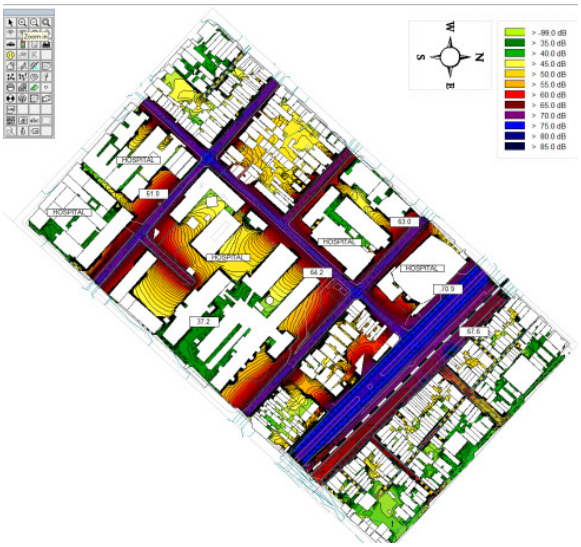

Figure 4. Stretch of the Couto Fernandes Stationnear the hospital complex**.**

- Occasional presentations of critical areas.

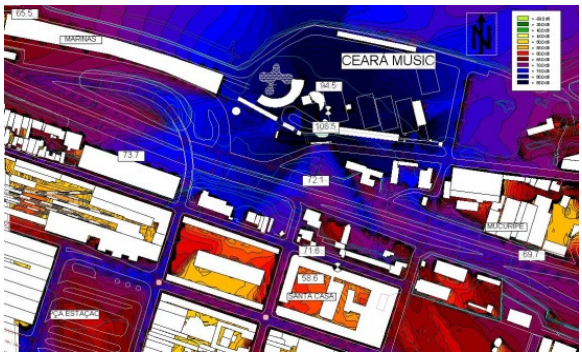

Figure 5. Show of Claudia Leite - Marina**.**

- Check and validate calculations with measurements at several points in the city.

- Format for presentation.

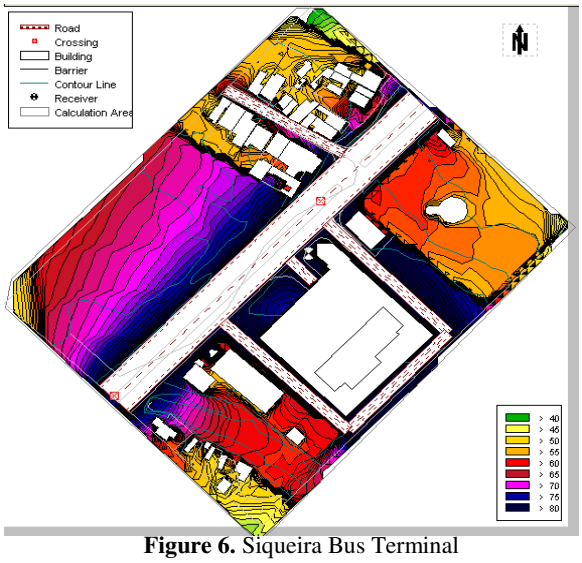

Figure 6. Siqueira Bus Terminal

Implementing the monitoring of the event Ceará Music, the following procedures were established:

- Noise monitoring prior to stretch, before deployment of the event, in order to define existing environmental noise, at times compatible with the event.
- Structuring plan for integration into the calculation software.
- Implementation of the map set to acoustic noise environment.
- Assembly and testing of equipment in the structure of the event on October 09, 2009, in the period from 14:00 to 17:00.

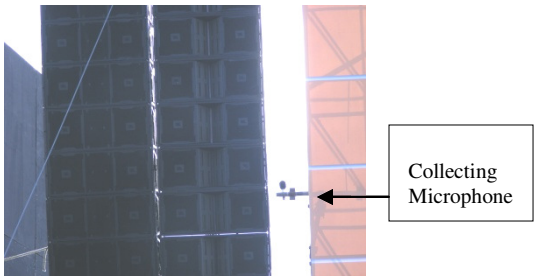

Figure 7. Collecting Microphone

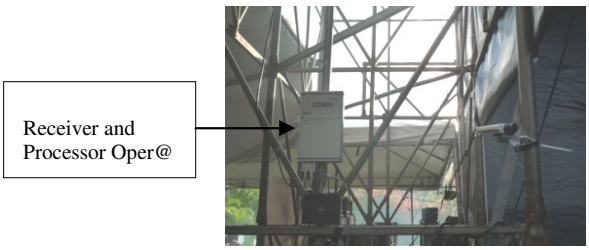

Figure 8. Receiver and Processor Oper@

- Calibration of instruments to be used.
- Beginning of the measurement procedures.
- Receiving data into the Control Station and the same treatment and verification and collection of data by external measurements, especially at the Holy House of Mercy Hospital.
- Implementation of environmental noise maps of the event and each musical group that presents itself.
- Insertion of the maps on the website of the City of Fortaleza together with technical information of the event, see Figures 9 and 10.

Website:

http://www.fortaleza.ce.gov.br/semam/index.php?option=com_content&task=view&id=84

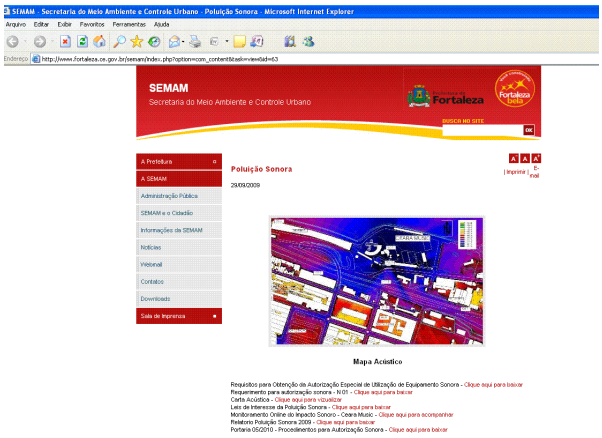

Figure 9. Website of the City of Fortaleza

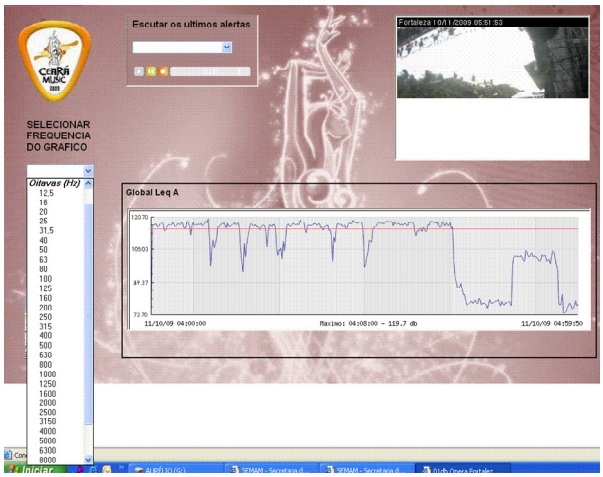

Figure 10. Technical Information in website

- Interaction with technical event for possible adjustments to fit the law.
- Final study of monitoring with the conclusions.

RESULTS AND DISCUSSION

The resulting maps show a number of critical situations in the city and help determine the impact that a noise source causes in a particular area of the municipality. In the case of the Ceará Music event, prior to the event there was a peak period for road traffic (7:00 pm) and there was the direct impact from the event, as well as the barrier effect created by technical event, to mitigate the effects to the Hospital, located in the vicinity of the event.

Therefore, taking advantage of the strands produced by the event, a model for monitoring procedures for future large events was developed and the result was a wide range of options for a refined analysis of the noise impact of an event of such size to establish the final acoustic map of the event

and show the real impact on the section selected for evaluation.

The noise maps depict different situations, the first featuring the environmental noise. It basically shows the strong influence of the road traffic in the stretch and the impact of natural and artificial barriers. The first map (Figure 11), shows the stretch when traffic is heavy (19:00). The second map (Figure 12) shows the environmental noise with some roads closed to the realization of the event and the acoustic structure fully assembled, with movement of vehicles on roads forbidden, as operational support for the event.

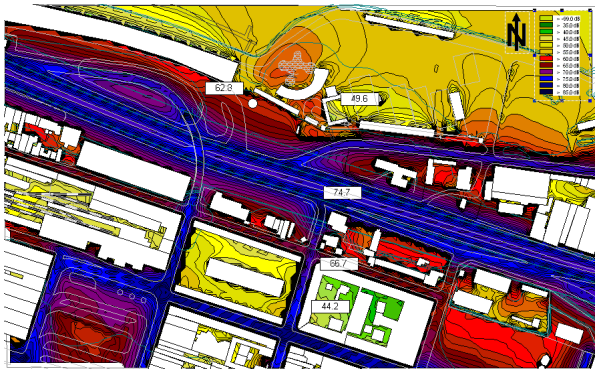

Figure 11. Intense Traffic

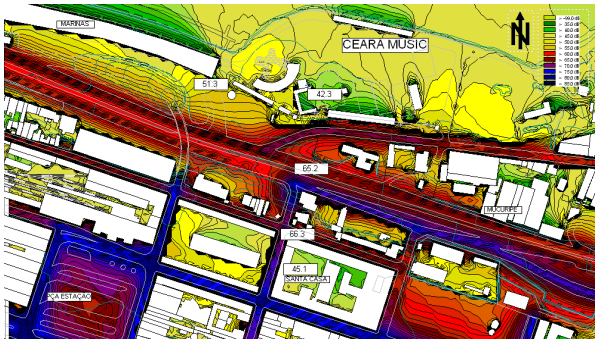

Figure 12. Closed Roads

The third map (Figure 13), depicts the sound from the CINE show where the noise impact of this show is so intense and the perceived effect of the acoustic barrier placed to mitigate the effects on the Holy House of Mercy Hospital is noticable.

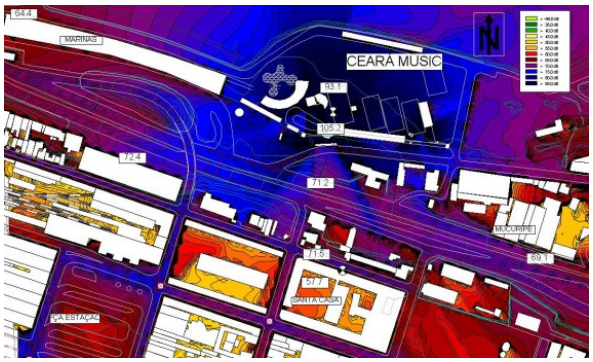

Figure 13. CINE musical show

To determine the behaviour of the musical events, the example of another show was used with a different sound performance with lower sound pressure levels, showing the diversity of styles presented there. The maps represented below show the show with singer Lulu (Figure 14), with LAeq 5 dB (A) lower than the CINE show (Figure 13).

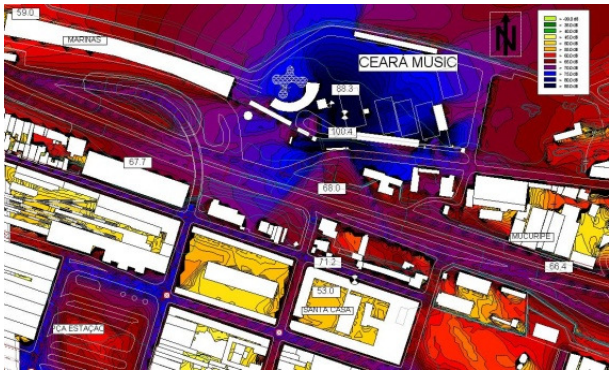

Figure 14. Lulu Santos musical show

The maps derived from data collected by the equipment, calculated with the software and techniques described, provided a wide range of information that contribute with a realistic understanding of the phenomena that occur during the event, as shown in the tables and graphs that follow. The behavior is shown in several concerts with fidelity and the oscillations of sound pressure level and certain specific characteristics define the concerts with major and minor impacts. The detail sets the individual profile of the event.

In Figures 15 and 16, a profile of each show is presented, both in terms of their noise indexes and octave band frequency distribution, referencing the most impactful and to provide knowledge for future noise control procedures. Figure 17 depicts the sound pressure level time history.

File	Total_dia2.CMG						
Location	Opera N°10208 Ch1						
Data type	Leq						
Weighting	A						
Start	10/10/09 09:35:10						
End	11/10/09 06:58:20						
Source	Leq specific dB	Leq (partial) %	Lmin dB	Lmax dB	L90 dB	L10 dB	Duration cumulated h:min:s
preparativos	100,5	4,0	57,8	118,1	61,1	104,6	09:26:30
CINE	116,0	11,0	67,7	121,2	100,8	118,7	00:43:30
interval	102,2	1,6	70,1	115,9	79,0	106,5	02:31:40
Roberta Sa	110,3	4,5	87,5	121,8	103,1	112,8	01:06:50
Skank	115,5	13,0	80,1	120,1	110,0	117,9	00:57:50
Lulu Santos	111,1	6,8	45,2	118,3	92,4	114,9	01:25:00
Jesus	109,0	1,2	83,2	116,3	104,9	111,6	00:23:30
Claudia Leite	116,9	26,1	81,8	122,7	110,2	119,7	01:25:10
CPM22	115,9	15,1	85,7	119,7	107,0	117,7	01:01:10
Biquini Cavadão	114,2	16,1	83,6	119,7	105,7	116,7	01:37:10
Listed sources together	111,1	99,3	45,2	122,7	63,7	116,4	20:38:20
Residual	104,1	0,7	45,1	118,1	70,0	107,6	00:44:50
Overall	110,9	100,0	45,1	122,7	63,9	116,3	21:23:10

Figure 15. *LAeq* Table

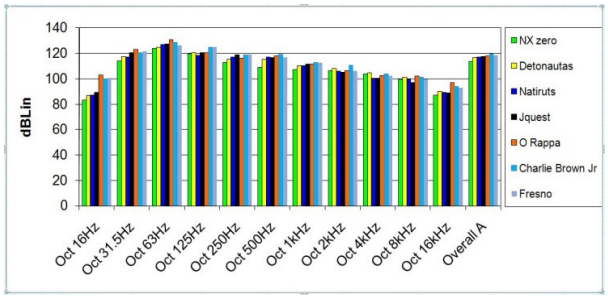

Figure 16. Frequency spectra

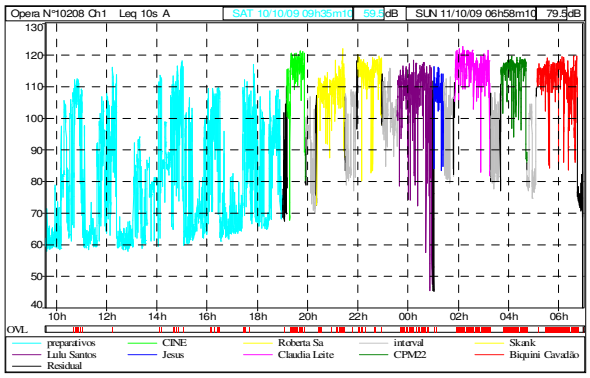

Figure 17. *LAeq* time history during the Festival

CONCLUSIONS

A noise map identifies the main sources of noise responsible for the disturbance of environmental noise in the municipal area. This information is a valuable tool in developing strategies in a hierarchical order for reduction and control of the noise generated by different actors in the urban soundscape.

The maps allow a careful analysis of the urban areas, to identify contributions of individual sound sources, road traffic, air traffic, rail traffic, industry, entertainment areas (as in the case of Ceará Music) or others. This information allows the establishment of parameters for technical assessment and yield a strategic help to define objective values for acoustical attenuation needed to reduce noise and to define rules for conservation and improvement of the sound environment, seeking the welfare and public peace.

In the specific case of acoustical monitoring of Ceará Music, the main objective of the study was to provide knowledge of the sound environment of a large event, seeking to understand the effects of the sound pressure that is emitted at levels that are high in the next street and cause a risk of considerable nuisance in the vicinity, in this case, the Holy House of Mercy Hospital.

The sound profiles found at concerts of the event were interesting. On the first day the levels of some groups were high, so that technical corrections to the event were requested, regarding the volume and control of some frequency band found as factors that highly impacted the results. In An agreement with the District Attorney, the noise profile of the event could not lead to levels above 55 dB (A) within the wards of the Hospital and as the graph show, in the first day sound pressure levels of 68 dB (A) on average and with the corrections effected were found. A new profile for the second day was met, ending with an average of 62 dB (A), with the windows open ward at the request of patrons of the same.

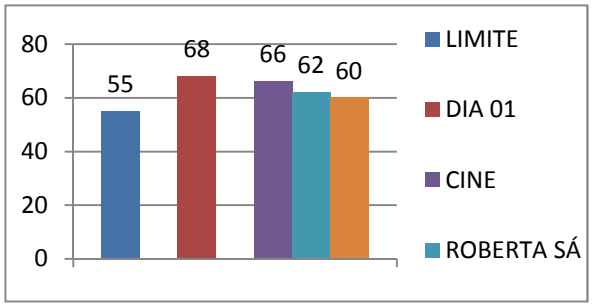

Figure 18: LAeq sound levels global average of different shows

Noise maps, event monitoring, assessment of the light rail metro near a hospital complex, showed that the highest nuisance result from traffic, with little influence of the rail. The study of the impact of aircraft noise led to a strategic profile of the main problems in relation to knowledge and control of noise impacting the city of Fortaleza, in order to facilitate future studies and attitudes for preventive and corrective actions, as well as a guiding strategic policy for policy makers, always seeking for a sound environment for sustainable Fortaleza.

ACKNOWLEDGEMENTS

Thanks to the Secretary of SEMAM Ramalho Deodato, who spared no efforts to achieve these projects, the promoters of the event Ceará Music that supply all the needs of the monitoring team to not obstruct any of the procedures, the District Attorney who promptly cradles the study and supported in full, the French company 01 dB for the loan of equipment and technical assistance and to Prof. Roberto and students of the Environmental Engineering and Mechatronics IFCE who showed dedication and interest spectacular.

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