

# Daniel Llamocca

RECONFIGURABLE COMPUTING RESEARCH LABORATORY (RECRLAB)

**Electrical and Computer Engineering Department**  
**School of Engineering and Computer Science (SECS)**  
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## PRIMARY AREAS OF ACTIVE RESEARCH INTERESTS

- Reconfigurable Computing, Embedded Systems.
- High-Performance Architectures for Computer Arithmetic, communications, embedded interfaces, digital video compression (H.264, HEVC), and digital signal/image/video processing.
- Dynamic multi-objective optimization and management of digital systems.
- Run-Time Partial Reconfiguration Techniques on FPGAs.
- Field Programmable Wiring Systems for power, analog, and digital signals.

## EDUCATION

**Ph.D., Computer Engineering**, The University of New Mexico, Albuquerque, May 2012

Dissertation: "Dynamically Reconfigurable Management of Energy, Performance, and Accuracy applied to Digital Signal, Image, and Video Processing Applications"

Advisor: Prof. Marios Pattichis

**M.S., Electrical Engineering**, The University of New Mexico, Albuquerque, 2008

**B.Sc., Electrical Engineering**, Pontificia Universidad Católica del Perú, Lima, Peru, 2002

## PROFESSIONAL EXPERIENCE

08/2014 – present	Assistant Professor, Electrical and Computer Engineering Department Oakland University
08/2013 - present	Research Assistant Professor, Dept. of Electrical and Computer Engineering, The University of New Mexico
01/2012 - 07/2013	Post-Doctoral Fellow, Dept. of LLSS, The University of New Mexico.
01/2006 - 12/2011	Graduate Research Assistant, Dept. of Electrical and Computer Engineering, The University of New Mexico.
08/2010 - 12/2010	Internship, K&A Wireless, LLC, Albuquerque.
09/2009 - 10/2009	Internship, Los Alamos National Laboratory, Los Alamos, New Mexico
01/2003 - 12/2005	Teaching Assistant, Dept. of Electrical Engineering, PUCP

## AWARDS

2004	Best paper award, "Study of the implementation of speech processing algorithms on FPGAs", <i>X Workshop IBERCHIP</i> , Cartagena de Indias, Colombia, <i>March 2004</i>
2000-2002	Undergraduate Scholarship Recipient of 'Fundación Educación' Organization ( <a href="http://www.fundeducation.org">http://www.fundeducation.org</a> ), which supports students in Latin America.

## PATENTS

- "System and Methods for Fast Discrete Periodic Radon Transform", Inventors: Cesar Carranza, **Daniel Llamocca**, Marios S. Pattichis, *Filed* Dec. 17, 2013.
- "System and Methods for Dynamic Management of Hardware Resources", Inventors: Marios S. Pattichis, Yuebing Jiang, and **Daniel Llamocca**, US Patent # 9,111,059, Issued August 18, 2015.

## TEACHING

### INSTRUCTOR

Electrical and Computer Engineering Department, Oakland University

- Taught the following undergraduate/graduate courses:
  - ✓ ECE278, Digital Logic Design, Fall 2016.
  - ✓ ECE495/595, Special Topics: Reconfigurable Computing, Fall 2015, Fall 2016.
  - ✓ ECE378, Computer Hardware Design, Winter 2016.
  - ✓ ECE378, Digital Logic and Microprocessor Design, Winter 2015.
  - ✓ ECE470/570, Microprocessor-Based System Design, Fall 2014.

Department of Electrical and Computer Engineering, The University of New Mexico

- Taught the following undergraduate courses:
  - ✓ ECE238L, Computer Logic Design, Fall 2013.
  - ✓ ECE314, Signals and Systems, Summer 2013.
- Taught the following workshop:
  - ✓ Digital Circuit Design with VHDL, Fall 2013.

### POST-DOCTORAL FELLOW

January 2012 – July 2013

College of Education, The University of New Mexico

- Collaborated in the development of a curriculum for middle-school students that used engineering problems (specifically digital signal, image, and video processing) to motivate and enhance students' understanding of mathematical concepts based on current research that integrates the fields of education and engineering ([aolme.unm.edu](http://aolme.unm.edu)).
- Developed the required software routines to aid in the teaching of image and video processing using i) MATLAB®, and ii) Python™ with the Raspberry Pi® computer.
- Worked on collaborative proposals to secure external funding.
- Participated in the implementation of the curriculum in an Out-of-School Summer Session (2012), an After-School Spring Session (2013), an Out-of-School Summer Session (2013), and an After-School Spring Session (2014).

### TEACHING ASSISTANT, LABORATORY INSTRUCTOR

January 2003 – December 2005

Electrical Engineering Department, Pontificia Universidad Católica del Perú

- Taught the following undergraduate courses: Programming Languages, Digital Circuits, Introduction to Electrical Engineering, Analog Circuits, Electrical Circuits, and Computer Architecture.

## RESEARCH

### SPONSORED RESEARCH

- *Self-Reconfigurable Architectures for the Next-Generation Video Compression Standard: HEVC (High Efficiency Video Coding)*. PI: **Daniel Llamocca**, \$9,878, University Research Committee - Oakland University, 05/2015 - 07/2015.
- *Excellence in Teaching and Learning - Course Implementation: Reconfigurable Computing*. PI: **Daniel Llamocca**, \$3,000, Center for Excellence in Teaching and Learning (CETL) – Oakland University, 05/2015 – 04/2016.
- *CSR: Small: Dynamically Reconfigurable Architectures for Time-varying Image Constraints (DRASTIC) Based on Local Modeling and User Constraint Prediction*. PI: Marios S. Pattichis, Co-PI: **Daniel Llamocca**, \$459,870, **NSF** (\$68,068 to Oakland University, subaward from the University of New Mexico), 10/2014 - 09/2017.

### JOURNAL ARTICLES

1. Carranza, C., Llamocca, D., and Pattichis, M., "Fast 2D Convolutions and Cross-Correlations using Scalable Architectures", *IEEE Transactions on Image Processing* (under review).
2. Carranza, C., Llamocca, D., and Pattichis, M., "Fast and Scalable Computation of the Forward and Inverse Discrete Periodic Radon Transform", *IEEE Transactions on Image Processing*, vol. 25, no. 1, pp. 119-133, January 2016.
3. Murray, V., Pattichis, M., Llamocca, D., and Lyke, J., "Field Programmable Wiring Systems", *Proceedings of the IEEE*, vol. 103, no. 7, pp. 1159-1180, July 2015.

4. Llamocca, D., Pattichis, M., "Dynamic Energy, Performance, and Accuracy Optimization and Management using automatically generated constraints for separable 2-D FIR filtering for digital video processing", *ACM Transactions on Reconfigurable Technology and Systems (TRETS)*, vol. 7, no. 4, Article 4, December 2014.
5. Llamocca, D., Murray, V., Jiang, Y., Pattichis, M., Lyke, J., and Avery, K., "Scalable Open-Source Architecture for Real-Time Monitoring of Adaptive Wiring Panels", *AIAA Journal of Aerospace Information Systems*, vol. 11, no. 6, pp. 344-358, June 2014.
6. Llamocca, D., Pattichis, M., "A Self-Reconfigurable Platform for the Implementation of 2D Filterbanks with Real and Complex-valued Inputs, Outputs, and Filter Coefficients", *VLSI Design*, vol. 2014, Article ID 651943, 24 pages, May 2014, doi: 10.1155/2014/651943.
7. Celedón-Pattichis, S., LópezLeiva, C.A., Pattichis, M.S., and Llamocca, D., "An interdisciplinary collaboration between computer engineering and mathematics/bilingual education to develop a curriculum for underrepresented middle school students", *Cultural Studies of Science Education*, vol. 8, no. 4, pp. 873-887, December 2013.
8. Murray, V., Llamocca, D., Lyke, J., Avery, K., Jiang, Y., and Pattichis, M., "Cell-based Architecture for Adaptive Wiring Panels: A First Prototype", *AIAA Journal of Aerospace Information Systems*, vol. 10, no. 4, pp. 187-208, April 2013.
9. Llamocca, D., Pattichis, M., "A Dynamically Reconfigurable Pixel Processor System based on Power/Energy-Performance-Accuracy Optimization", *IEEE Transactions on Circuits and Systems for Video Technology*, vol. 23, no. 3, pp. 488-502, March 2013.
10. Llamocca, D., Pattichis, M., and Vera A., "Partial Reconfigurable FIR Filtering system using Distributed Arithmetic", *International Journal of Reconfigurable Computing*, vol. 2010, Article ID 357978, 14 pages, Dec. 2010, doi: 10.1155/2010/367978.
11. Llamocca, D., Agurto, C., "A fixed point implementation of the expanded hyperbolic CORDIC algorithm", *Latin American Applied Research, Special Issue on Programmable Logic*, vol. 37 no.1, pp. 83-91, Bahía Blanca, Argentina, January-March 2007.

#### CONFERENCE PAPERS

1. Jacoby, A., Llamocca, D., "Dual Fixed-Point CORDIC Processor: Architecture and FPGA Implementation", to appear in *Proceedings of the 11<sup>th</sup> International Conference on Reconfigurable Computing and FPGAs (RECONFIG2016)*, Cancun, Mexico, Dec. 2016.
2. Llamocca, D., and Aloï, D., "A Reconfigurable Fixed-Point Architecture for Adaptive Beamforming", in *Proceedings of the 23<sup>rd</sup> Reconfigurable Architectures Workshop (RAW'2016)*, Chicago, Illinois, May 2016.
3. Llamocca, D., "Design and Implementation of a Reconfigurable Computing Course for efficient Hardware/Software Co-Design in Reconfigurable Systems", in *Proceedings of the 2016 ASEE Northeast Section Conference*, Kingston, Rhode Island, April 2016.
4. Mack, J., Bellestri, S., Llamocca, D., "Floating Point CORDIC-based Architecture for Powering Computation", in *Proceedings of the 10<sup>th</sup> International Conference on Reconfigurable Computing and FPGAs (RECONFIG2015)*, Mayan Riviera, Mexico, Dec. 2015.
5. Llamocca, D., and Dean, B.K., "A Scalable Pipelined Architecture for Biomimetic Vision Sensors", in *Proceedings of the 25<sup>th</sup> International Conference on Field Programmable Logic and Applications (FPL'2015)*, London, United Kingdom, Sep. 2015.
6. Carranza, C., Llamocca, D., and Pattichis, M., "A Scalable Architecture for Implementing the Fast Discrete Periodic Radon Transform for Prime Sized Images", in *Proceedings of the 2014 IEEE International Conference on Image Processing (ICIP'2014)*, Paris, France, October 2014.
7. Jiang, Y., Llamocca, D., Pattichis, M., and Esakki, G., "A Unified and Pipelined Hardware Architecture for Implementing Intra Prediction in HEVC", in *Proceedings of the 2014 IEEE Southwest Symposium on Image Analysis and Interpretation*, San Diego, CA, April 2014.
8. Carranza, C., Llamocca, D., and Pattichis, M., "The Fast Discrete Periodic Radon Transform for Prime Sized Images: Algorithm, Architecture, and VLSI/FPGA Implementation", in *Proceedings of the 2014 IEEE Southwest Symposium on Image Analysis and Interpretation*, San Diego, CA, April 2014.
9. Jacoby, A., Llamocca, D., Jordan, R., and Vera, G.A., "Proteus: An Open Source Dynamically Reconfigurable System-on-Chip with applications to Digital Signal Processing", in *Proceedings of the 9<sup>th</sup> International Caribbean Conference on Devices, Circuits and Systems*, Playa del Carmen, Mexico, April 2014.
10. LópezLeiva, C.A., Celedón-Pattichis, S., Pattichis, M.S., and Llamocca, D., "Image representation in a middle school afterschool program", in *Proceedings of the 4<sup>th</sup> International Realistic Mathematics Education Conference*, Boulder, Colorado, Sep. 2013.
11. LópezLeiva, C., Celedón-Pattichis, S., Pattichis, M.S., and Llamocca, D., "Successes and challenges of supporting interactive learning in a mathematics and engineering afterschool program for middle school students", in *Proceedings of the 2013 Annual meeting of the American Educational Research Association*, San Francisco, California, April 2013.

12. Llamocca, D., Carranza, C., Pattichis, M., "Dynamic Multiobjective Optimization Management of the Energy-Performance-Accuracy Space for Separable 2-D Complex filters", in *Proceedings of the 22<sup>nd</sup> International Conference on Field Programmable Logic and Applications (FPL'2012)*, Oslo, Norway, Aug. 2012.
13. Llamocca, D., Pattichis, M., Carranza, C., "A framework for self-reconfigurable DCTs based on Multiobjective Optimization of the Power-Performance-Accuracy space", in *Proceedings of the 7th International Workshop on Reconfigurable Communication-centric Systems-on-Chip (RECOSOC'2012)*, York, United Kingdom, July 2012.
14. Llamocca, D., Carranza, C., Pattichis, M., "Separable FIR Filtering in FPGA and GPU implementations: Energy, Performance, and Accuracy Considerations", in *Proceedings of the 21<sup>st</sup> International Conference on Field Programmable Logic and Applications (FPL'2011)*, Chania, Greece, Sept. 2011.
15. Murray, V., Llamocca, D., Lyke, J.C., Avery, K., Jiang, Y., and Pattichis, "Cell-based Architecture For Adaptive Wiring Panels: A First Approach", in *Proceedings of the AIAA Reinventing Space Conference*, Los Angeles, CA, May 2011.
16. Steinwart, I., Theiler, J., Llamocca, D., "Using Support Vector Machines for Anomalous change detection", in *Proceedings of the 2010 IEEE International Geoscience and Remote Sensing Symposium*, Honolulu, Hawaii, July 2010.
17. Llamocca, D., Pattichis, M., "Real-time Dynamically Reconfigurable 2-D Filterbanks", in *Proceedings of the 2010 IEEE Southwest Symposium on Image Analysis and Interpretation*, Austin, Texas, May 2010.
18. Llamocca, D., Pattichis, M., Vera, A., Lyke, J., "Dynamic Partial Reconfiguration through Ethernet Link", in *Proceedings of the AIAA Infotech@Aerospace 2010 Conference and Exhibit*, Atlanta, Georgia, April 2010.
19. Llamocca, D., Pattichis, M., Vera, A., "A dynamically reconfigurable platform for Fixed-Point FIR Filters", in *Proceedings of the 2009 International Conference on Reconfigurable Computing and FPGAs (RECONFIG'09)*, Cancun, Mexico, Dec. 2009.
20. Vera, A., Llamocca, D., Pattichis, M., Lyke, J., "A Dynamically Reconfigurable Computing Model for Video Processing Applications", in *Proceedings of the 2009 Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove, California, Nov. 2009.
21. Llamocca, D., Vera, A., Pattichis, M., "A Dynamic Computing Platform for Image and Video Processing Applications", in *Proceedings of the 2009 Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove, California, Nov. 2009.
22. Llamocca, D., Pattichis, M., Vera, A., "A dynamically reconfigurable parallel pixel processing system", in *Proceedings of the 19<sup>th</sup> International Conference on Field Programmable Logic and Applications (FPL'2009)*, Prague, Czech Republic, Sept. 2009.
23. Vera, A., Llamocca, D., Fabula, J., Kemp, W., Marquez, R., Shedd, W., Alexander, D., "Xilinx Virtex V Field Programmable Gate Array Dose Rate Upset Investigations", in *Proceedings of the IEEE Radiation Effects Data Workshop*, Tucson, Arizona, July 2008.
24. Vera, A., Llamocca, D., Pattichis, M., Kemp, W., Sheed, W., Alexander, D., Lyke, J., "Dose Rate Upset Investigations on the Xilinx's Virtex IV Field Programmable Gate Arrays", in *Proceedings of the IEEE Radiation Effects Data Workshop*, Honolulu, Hawaii, July 2007.
25. Llamocca, D., Agurto, C., "A Fixed-point implementation of the expanded hyperbolic CORDIC algorithm", in *Proceedings XII Workshop IBERCHIP*, San Jose, Costa Rica, March 2006.
26. Llamocca, D., Agurto, C., "A Fixed-point implementation of the natural logarithm based on an expanded hyperbolic CORDIC algorithm", in *Proceedings XII Workshop IBERCHIP*, San Jose, Costa Rica, March 2006.
27. Llamocca, D., Crisostomo, P., "An architecture for real-time interaction between an analog radar and a personal computer", in *Proceedings XII Workshop IBERCHIP*, San Jose, Costa Rica, March 2006.
28. Llamocca, D., "A Core design to obtain square root based on a non-restoring algorithm", in *Proceedings XI Workshop IBERCHIP*, Salvador da Bahia, Brazil, March 2005.
29. Llamocca, D., "Implementation of a speech encoder based in the LPC-10 algorithm on a FPGA", in *Proceedings ICED/CASTOUR*, Veracruz, México, November 2004.
30. Llamocca, D., "Study of the implementation of speech processing algorithms in FPGAs", in *Proceedings X Workshop IBERCHIP*, Cartagena de Indias, Colombia, March 2004 (best paper award).

## PRESENTATIONS

- "A framework for Run-Time Reconfigurable Computing", **Oakland University**, Rochester, Michigan, October 24, 2014.
- "Introduction to Digital Logic Design: Stopwatch Design", **California State University-Chico**, Chico, California, April 2, 2014.
- "Dynamically Reconfigurable Architecture Systems for Time-Varying Image Processing Constraints (DRASTIC) applied to Image Analysis", **California State University-Chico**, Chico, California, April 2, 2014.
- "Dynamically Reconfigurable Architecture Systems for Time-Varying Image Processing Constraints (DRASTIC) applied to Image Analysis", **Oakland University**, Rochester, Michigan, March 31, 2014.

- "Dynamically Reconfigurable Architecture Systems for Time-Varying Image Processing Constraints (DRASTIC) applied to Image Analysis", **University of Texas - Pan American**, Edinburg, Texas, March 19, 2014.
- "Dynamically Reconfigurable Architecture Systems for Time-Varying Image Processing Constraints (DRASTIC) applied to Image Analysis", **University of Colorado at Colorado Springs**, Colorado Springs, Colorado, February 19, 2014.
- "A Framework for Dynamically Reconfigurable Architectures", **Lafayette College**, Easton, Pennsylvania, January 27, 2014
- "Dynamically Reconfigurable Architecture Systems for Time-Varying Image Processing Constraints (DRASTIC) applied to Image Analysis", **University of Michigan-Dearborn**, Dearborn, Michigan, January 24, 2014.
- "Dynamically Reconfigurable Architectures under Time Varying Constraints", **University of Texas at El Paso**, El Paso, Texas, December 11, 2013.
- "A Framework for Dynamic Management of Reconfigurable Architectures under Run-Time constraints", **Texas Tech University**, Lubbock, Texas, March 25, 2013.
- "A Method for Optimized Management of Run-Time Reconfigurable Architectures", **Northern Illinois University**, DeKalb, Illinois, March 5, 2013.
- "Dynamic Management and Optimization of Reconfigurable Architectures under Run-Time Requirements", **San Francisco State University**, San Francisco, California, Feb. 18, 2013.
- "Stack Frames", **Penn State Erie, The Behrend College**, Erie, Pennsylvania, Feb. 15, 2013.
- "A Framework for Dynamic Management of Reconfigurable Architectures under Run-Time constraints", **Penn State Erie, The Behrend College**, Erie, Pennsylvania, Feb. 15, 2013.
- "Dynamically Reconfigurable Computing under Time-varying Constraints", **Ohio Northern University**, Ada, Ohio, Jan. 23, 2013.

## SERVICE

### OAKLAND UNIVERSITY SERVICE

- School of Engineering and Computer Science.
  - ✓ Executive Committee Chair (Sep. 2016 – present).
  - ✓ Executive Committee Member (Aug. 2014 – August 2016).
- Electrical and Computer Engineering Department. Graduate Affairs Committee (Aug. 2014 - present).
- IEEE @ Oakland University – Student Branch: Faculty Advisor (March, 2016 – present)
- Electrical and Computer Engineering Department. Computer Engineering Program Committee (Aug. 2014 – present).

### THESIS AND DISSERTATION COMMITTEES

- Lakshmi Padmaja Angaluru Venkata (OU), "HEVC Encoder: Software implementation and Embedded System Design for Transform and Scaling", defended on March 3<sup>rd</sup>, 2016. Chair: Daniel Llamocca
- Cesar Carranza, Ph.D., Computer Engineering (UNM), "Fast and Scalable Computation of the Forward and Inverse Discrete Periodic Radon Transform", defended on December 17, 2015. Chair: Prof. Marios Pattichis.
- Gangadharan Esakki, M.S. Computer Engineering (UNM), "Dynamic Switching of GOP Configurations in High Efficiency Video Coding (HEVC) with Relational Databases for Multi-objective Optimization", defended on July 14, 2014. Chair: Prof. Marios Pattichis.

### REVIEWER: JOURNALS AND CONFERENCES

- IEEE Transactions on Signal Processing
- IEEE Transactions on Image Processing (2010 - present)
- IEEE Transactions on Circuits and Systems Part II: Express Briefs (2013 - present)
- IEEE Transactions on Industrial Informatics (2014 - present)
- Journal of Circuits, Systems, and Computers (JCSC) (2014 - present)
- Measurement - Journal of the International Measurement Confederation (2013 - present)
- IEEE International Conference on Image Processing (2013 - present)
- IEEE International Conference on BioInformatics and BioEngineering (2012 - present)

### PROFESSIONAL MEMBERSHIPS

- Institute of Electrical and Electronics Engineers (IEEE), Senior Member
- IEEE Circuits and Systems Society
- Society of Automotive Engineers (SAE)

## MISCELLANEOUS

### GRADUATE STUDENT ASSOCIATION (GSA) - TREASURER

June 2008 – June 2009

Department of Electrical and Computer Engineering, University of New Mexico, Albuquerque, NM.

- Organized social activities and provided graduate students with funds for dissertation defense, conference travel, etc.

### LANGUAGES

- Native Spanish speaker, fluent in English.

## SELECTED RESEARCH PROJECTS

- **ADAPTIVE WIRING PANEL FOR SPACE APPLICATIONS** August 2010 - December 2011  
Department of Electrical and Computer Engineering, The University of New Mexico
  - ✓ Design of an Adaptive Wiring Panel that can route power, analog, and digital signal through an array of solid state relays. This was an Airforce Research Labs (AFRL) project.
  - ✓ Development of a command-line software interface for the Adaptive Wiring Panel. The software utilized graph algorithms to perform optimized usage of the relays based on a user-defined circuit to implement.
  - ✓ Mechanical design of the prototypes as well as the layout of the hardware components. Three prototypes were designed and successfully tested.
  - ✓ Design of an array of Printed Circuit Board (PCB) layouts for the Adaptive Wiring Panel. Each PCB contained an FPGA, a set of solid state relays, and ancillary components.
- **HIGH-PERFORMANCE MEDICAL IMAGING VISUALIZATION SYSTEM** August 2010 - December 2010  
K & A Wireless LLC, Albuquerque, NM.
  - ✓ Implementation of an image processing algorithm (MATLAB platform) that counts objects inside a box for medical purposes (Phase I SBIR) using segmentation, morphology, and filtering.
  - ✓ Assessment of the resource and memory requirements for the implementation of the algorithm inside an embedded microprocessor.
  - ✓ Result were included in a Phase II SBIR Proposal, which was eventually granted.
- **GPU IMPLEMENTATION OF A SUPPORT VECTOR MACHINE (SVM)** September 2009 - October 2009  
Los Alamos National Laboratory, Los Alamos, NM.
  - ✓ Implementation of a Support Vector Machine (testing) for Anomalous Change Detection on an array of Graphic Processing Units (GPU).
  - ✓ Platform used: C++ for CUDA under a Linux environment.
  - ✓ The GPU implementation resulted in a twenty-fold improvement in execution time compared to a multi-threaded CPU implementation.

## REFERENCES

1. **Marios Pattichis** – Former Academic Advisor  
Full Professor  
Department of Electrical and Computer Engineering, MSC01 1100, 1 University of New Mexico, ECE Bldg., Room 229A, Albuquerque, NM, 87131  
email: [pattichis@ece.unm.edu](mailto:pattichis@ece.unm.edu)
2. **Ingo Steinwart**  
Full Professor  
Institute for Stochastics and Applications, Department of Mathematics,  
University of Stuttgart  
email: [Ingo.Steinwart@mathematik.uni-stuttgart.de](mailto:Ingo.Steinwart@mathematik.uni-stuttgart.de)
3. **Ramiro Jordán** - Director of ECE-UNM Undergraduate Program  
Associate Professor  
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4. **Carlos López-Leiva**  
Assistant Professor  
College of Education, 1 University of New Mexico, Albuquerque, NM, 87131  
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5. **Alonzo Vera**  
Configurable Space Microsystems Innovations & Applications Center (COSMIAC)  
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