The Reality of Picture Archiving and Communication Systems (PACS): A Survey
Roger A. Bauman and Guenther Gell

Toward the end of 1997 vendors were succeeding in installing picture, archiving and communication systems (PACS) in larger numbers. It was hard to separate fact from fiction at times. This survey was undertaken by 2 members of the academic community to confirm what was operational, how well the installed systems worked, and what they were doing. Fax questionnaires were sent to nearly 1,000 facilities worldwide to identify PACS of any size in clinical operation on a date certain, February 1, 1998. A total of 177 PACS were identified. Facilities furnished responses during the first survey period from May 1 to November 1, 1998. A second survey, done in February and March of 2000, sought long-term follow-up data. Many systems operated 5 or more types of modalities. Computed tomography (CT) was the most common modality type at 83%, but the distribution of the rest held surprises. There also was an unexpectedly large use of soft copy reading and filmless operation in 1998. Clear trends toward increased use of computed radiography and digital radiography and a significant expansion on the percentage of all of a facility’s examinations on the PACS were seen over the 2 years. Satisfaction with original PACS vendors was relatively high. Eighty-nine percent remained with their original vendor. Only 10 sites reported they changed vendors, and 4 facilities said they abandoned their system. The users reported their expectations of the PACS had been met in 81% of cases. Some (65%) declared their systems were cost effective. The most striking response was that 97% of the users would recommend PACS to others.

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When people began to envision picture, archiving, and communication systems (PACS) about 20 years ago, the computer hardware then existing was not up to the task. Demonstration projects in academic institutions began to explore the vision. Hardware limitations like the speed and capacity of disk drives, standard network protocols, and the limited resolution and contrast of electronic displays were very real barriers to clinical operations.

Most of these efforts were done internally at academic institutions, although some were in cooperation with industry. Smaller projects aggregated into larger ones, and, at last, some PACS emerged. In 1993 a survey found 13 large PACS,1 and a 1995 survey found the number of large PACS had grown to 23.2,3 The definition of large PACS used in those and this survey can be found in the discussion section.

The later 1990s in particular saw very large gains in the technical performance of central processing units; RAM memory; disk storage speeds and capacity; the broad availability of faster standard networks like FDDI, ATM, and fast Ethernet; and, more recently, improvement in long-term archive capacities and speed. Also important were improvements in the quality of software, in the interfaces with other information systems, and advances in the DICOM and HL7 standards. These advances occurred as prices decreased, and many commercial vendors began to offer PACS.

At large radiology meetings users would wonder if they were the only department that had not yet ordered a PACS. Further, these systems operated nearly without flaw, it would seem. Where were all those other hospitals getting large sums of money for PACS in a time of health care underfunding? How real are these impressions? How real is PACS? This study was undertaken to address such questions as well as to ascertain what features were in clinical use on both older and more modern PACS.

It was decided to survey a large group of facilities without attempting to locate every last PACS. Only systems in actual clinical operation on a certain date, February 1, 1998, would be eligible. Systems of any size in hospitals of all sizes and outpatient facilities would be included. The survey was designed with 2 inquiry periods. The first was conducted from 3 to 9 months after the February 1 date to gather initial impressions and judgments.
### 3rd Worldwide PACS Survey as of February 1, 1998

1. What is your hospital total bed size? 
   - Acute beds only? 
   - Total bed size in entire enterprise system? 

2. Did you have a PACS in clinical operation on February 1, 1998? 
   - Yes ☐ No ☐

3. If not, do you plan to install one within two years? 
   - Yes ☐ No ☐

4. Which does your PACS serve? 
   - Radiology only? ☐ Your hospital only? ☐ Your enterprise members only? ☐ Other? 

5. Was your PACS: 
   - Developed in-house only? ☐ Mix of in-house & Commercial? ☐ Commercial only? ☐

6. Who is your main PACS vendor? 

7. Who is your PACS integrator? 

8. Do you do teleradiology? 
   - Yes ☐ No ☐

9. Are display terminals outside of radiology connected via: 
   - DICOM? ☐ Intranet? ☐ Other? ☐

10. How many display terminals outside of radiology? 
   - In radiology? How many of these are diagnostic workstations?

11. Has your PACS met your expectations? 
   - Yes ☐ No ☐

12. Is your PACS cost effective? 
   - Yes ☐ No ☐

13. Would you recommend PACS to others? 
   - Yes ☐ No ☐

14. Total annual number of exams?

15. Please list any unsolved or vexing problems.

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**For this modality specific data use approximations if necessary.**

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<tr>
<th>Modality</th>
<th>Total Number of devices</th>
<th>Per cent of modality on PACS?</th>
<th>Per cent of soft copy primary reading?</th>
<th>Per cent of filmless studies?</th>
<th>Percent stored in long term archive?</th>
<th>Compression ratio in long term archive?</th>
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Fig 1. This is the survey form used in the first survey period, that is, 3 to 9 months after the February 1, 1998. It usually was faxed with a cover sheet. The name and telephone of the recipient (above question 9) and the facility name and address (in the lower right hand corner) usually were printed on the form from the database. The form also served as both a cover sheet and the message as a return fax, because the block on the left contained the name and fax number of one of the authors.